Revised 3/00

CORRES. CONTROL
INCOMING LTR NO.

00354 RF 00

DUE DATE

ACTION

DIST.	LTR	ENC
BACA, T.		
BOGENBERGER, V.		
BRAILSFORD, M.D.		
CARD, R.G.		
COX, C.M.		
CRAWFORD, A.C.		
DERBY, S.		
DIETERLE, S.E.		
FERRERA, D.W.		
FERRERA, K.P.		
FERRI, M.S.		
FULTON, J.C.		
GERMAIN, A.L.		
GIACOMINI, J.		
HARROUN, W.P.		
HEDAHL, T.G.		
ISOM, J.H.		
LEONARD, R.C.		
MARTINEZ, L.A.		
NORTH, K.		
PARKER, A.M.		
PHILLIPS, F.J.	✓	
RODGERS, A.D.		
SANDLIN, N.B.		
SHELTON, D.C.		
SPEARS, M.		
TUOR, N.R.		
VOORHEIS, G.M.		
WARTHER, R.F.		
Butler, L	✓	
Boyan, E	✓	

COR. CONTROL	X	X
ADMN. RECORD	✓	✓
PATS/T130G		

Reviewed for Addressee
Corres. Control RFP

4/3/00
Date By

Ref Ltr. #

DOE ORDER # None

1/82

Department of Energy

ROCKY FLATS FIELD OFFICE
P.O. BOX 928
GOLDEN, COLORADO 80402-0928

3 APR 00 11:56

RFETS-CC

MAR 30 2000

00-DOE-02148

Mr. Steven Gunderson
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, CO 80222-1530

Dear Mr. Gunderson:

Enclosed please find a copy of the "Draft Sampling and Analysis Plan for the Characterization of Under Building Contamination for UBC 123 and Building 886, Implementing Horizontal Directional Drilling and Environmental-Measurement-While-Drilling" dated March 2000. The work is funded through the Office of Science and Technology at EM-50, and we are tentatively scheduled to begin work in June 2000. The Department of Energy requests review and comment of the Sampling and Analysis Plan (SAP) by April 11, 2000. The Department of Energy is also sending copies to the Environmental Protection Agency, Region VIII.

If you have any questions related to this SAP, please contact me at (303) 966-5918, or Norma Castaneda, of my staff, at (303) 966-4226.

Sincerely,

for Joseph A. Legare
Assistant Manager
for Environment and Infrastructure

Enclosure

cc w/Encl.:
C. Spreng, CDPHE
G. Kleeman, EPA
T. Rehder, EPA
Administrative Record

ADMIN RECORD

APR 2000
RECEIVED
RECORDS CENTER

SW-A-003947

cc w/o Encl.:
J. Rampe, DAMEI, RFFO
R. Tyler, ERWM, RFFO
N. Castaneda, ERWM, RFFO
S. Bell, OCC, RFFO
L. Butler, K-H

2

KAISER•HILL
COMPANY

RF/RMRS-2000-018

Draft
Sampling and Analysis Plan for the Characterization of Under Building Contamination for UBC 123 and Building 886, Implementing Horizontal Directional Drilling and Environmental-Measurement-While-Drilling

Environmental Restoration
Rocky Flats Environmental Technology Site

March 2000
Revision D

RF/RMRS-2000-018

Draft
Sampling and Analysis Plan for the Characterization of Under Building Contamination for UBC 123 and Building 886, Implementing Horizontal Directional Drilling and Environmental-Measurement-While-Drilling

March 2000
Revision D

4

DRAFT SAMPLING AND ANALYSIS PLAN FOR THE CHARACTERIZATION OF UNDER BUILDING CONTAMINATION FOR UBC 123 AND BUILDING 886, IMPLEMENTING HORIZONTAL DIRECTIONAL DRILLING AND ENVIRONMENTAL-MEASUREMENT-WHILE-DRILLING

RF/RMRS-2000-018

Revision D

March, 2000

This Sampling and Analysis Plan has been reviewed and approved by:

R. L. Norland, Technical Support Manager	3/28/00 Date
T. M. Lindsay, Project Manager	3/28/00 Date
for M.C. Broussard, Characterization and Data Management Coordinator	3/28/00 Date
J.H. Moore, Quality Assurance	3/28/00 Date
R. P. Neveau, Radiological Engineering	3-28-00 Date

TABLE OF CONTENTS

6

TABLE OF CONTENTS (continued)

TABLES

FIGURES

APPENDICIES

PLATES

7

ACRONYMS

AC	alternating current
AHA	Activity Hazards Analysis
AL	Action Level
ALF	Action Levels Standards Framework for Surface Water, Ground Water and Soil
Am	americium
ASD	Analytical Services Division
Be	beryllium
bgs	below ground surface
bps	bits per second (baud)
BTEX	benzene, toluene, ethylbenzene, and xylenes
$C_2H_4O_2$	acetic acid
CA	Contamination Area
COC	Contaminant of Concern
Cm	curium
Cs	cesium
DC	direct current
D&D	Decontamination and Decommissioning
DER	Duplicate Error Ratio
DOE	U. S. Department of Energy
DOT	Department of Transportation
DQO	Data Quality Objective
EDD	Electronic Disc Deliverable
EM-50	U.S. Department of Energy EM-50 Group, Office of Science and Technology
EMWD	Environmental-Measurement-While-Drilling
EMSL	Environmental Monitoring Support Laboratory
EPA	U. S. Environmental Protection Agency
ER	Environmental Restoration
FID	Flame Ionization Detector
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FO	Field Operations
GC/MS	Gas Chromatography/Mass Spectrometry
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GRS	Gamma Ray Spectrometer
H&S	Health and Safety
H_2SO_4	sulfuric acid
Hanford	Technology Test Site, Hanford, Washington
HASP	Health and Safety Plan
HCl	hydrochloric acid
$HClO_4$	perchloric acid
HDD	Horizontal Directional Drilling
HEUN	Highly Enriched Uranyl Nitrate
HF	hydrofluoric acid
Hg	mercury
HNO_3	nitric acid

8

ACRONYMS (continued)

HPGe	high-purity germanium
HRR	Historical Release Report
HSS	Heath and Safety Specialist
IA	Industrial Area
IC	integrated circuit
IHSS	Individual Hazardous Substance Site
IWCP	Integrated Work Control Package
kPa	kilopascal(s)
ma	milliamp(s)
MH	manhole
mm	millimeter(s)
NaI	sodium iodide
NaOH	sodium hydroxide
NFA	No Further Action
NH_4OH	ammonium hydroxide
NPWL	New Process Waste Line
NRZ	Non-Returning to Zero
OD	outside diameter
OP	Operating Procedure
OPWL	Original Process Waste Line
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi/L	picocuries per liter
PCOC	Potential Contaminant of Concern
PID	Photoionization detector
PPE	personal protective equipment
psi	pounds per square inch
Pu	plutonium
QA/QC	Quality Assurance/Quality Control
QAPD	Quality Assurance Program Description
RBA	Radiological Buffer Area
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RF	Radio Frequency
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RIN	Report Identification Number
RLC	Reconnaissance Level Characterization
RPD	Relative Percent Difference
RSP	Radiological Safety Process
RWP	Radiological Work Permit

9

ACRONYMS (continued)

Sandia	Sandia National Laboratories, Albuquerque, New Mexico
SAP	Sampling and Analysis Plan
Site	Rock Flats Environmental Technology Site
SOP	Standard Operating Procedures(s)
SP	Source Pit
SRS	Savannah River Site
SVOC	Semi-Volatile Organic Compound(s)
SWD	Soil/Water Database
TAL	Target Analyte List
TCFM	trichlorofluoromethane
TCL	Target Compound List
U	uranium
UBC	Under Building Contamination
UCL	Upper Confidence Limit
μg/L	micrograms per liter
V	volt(s)
VOC	Volatile Organic Compound
WPS	Waste Pumping Station

LIST OF APPLICABLE STANDARD OPERATING PROCEDURES (SOPs)

Identification Number	Procedure Title
2-S47-ER-ADM-05.14	*Use of Field Logbooks and Forms*
RF/RMRS-98-200	*Evaluation of Data for Usability in Final Reports*
4-S01-ENV-OPS-FO.03	*Field Decontamination Operations*
4-F99-ENV-OPS-FO.23	*Management of Soil and Sediment Investigative Derived Materials*
4-H46-ENV-OPS-FO.29	*Disposition of Soil and Sediment Investigation-Derived Materials*
1-PRO-573-SWODP	*Sanitary Waste Offsite Disposal Procedure*
RMRS/OPS-PRO.112	*Handling of Field Decontamination Water*
RMRS/OPS-PRO.069	*Containing, Preserving, Handling and Shipping of Soil and Water Samples*
PRO-908-ASD-004	*On-Site Transfer and Off-Site Shipment of Samples*
RMRS/OPS-PRO.070	*Equipment Decontamination at Decontamination Facilities*
5-21000-OPS-FO.16	*Field Radiological Measurements*
RMRS/OPS-PRO.114	*Drilling and Sampling Using Hollow-Stem Auger and Rotary Drilling and Rock Coring Techniques*
RMRS/OPS-PRO.117	*Plugging and Abandonment of Boreholes*
RMRS/OPS-PRO.102	*Borehole Clearing*
RMRS/OPS-PRO.121	*Soil Gas Sampling and Field Analysis*
RMRS/OPS-PRO.123	*Land Surveying*
RMRS/OPS-PRO.124	*Push Subsurface Soil Sampling*
3-PRO-140-RSP-09.03	*Radiological Characterization of Bulk or Volume Solid Materials*
RM-06.02	*Records Identification, Generation and Transmittal*
RM-06.04	*Administrative Record Document Identification and Transmittal*
ASD-003	*Identification System for Reports and Samples*

11

1.0 INTRODUCTION

The Rocky Flats Environmental Technology Site (RFETS or the Site) is on the path towards closure. RFETS has 31 buildings with suspected or verified Under Building Contamination (UBC) that is the result of suspected or documented spills or leaks from building processes, Original Process Waste Lines (OPWL), New Process Waste Lines (NPWL), or operations adjacent to the buildings. Because of the compressed schedule required to reach closure by 2006, UBC characterization must take place concurrently with building deactivation, or decontamination where deactivation is not required, and cannot disrupt building activities. Therefore, methods to characterize UBC sites with minimal impact to buildings must be developed.

Sandia National Laboratory (Sandia) has successfully demonstrated the Environmental Measurement-While-Drilling (EMWD) system and Horizontal Directional Drilling (HDD) at the U.S. Department of Energy's (DOE) Hanford Site (Hanford) and Savannah River Site (SRS). The combination of these two technologies provides a potential new tool for characterizing UBC sites.

UBC sites are complex and consist of a number of components that must be considered during characterization. These may include contaminated structures, OPWLs, NPWLs, utilities both above and beneath buildings, valve vaults, energized systems, unknown contamination sources, multi-story basements, free-standing water beneath slabs or basements, and/or other associated contaminated areas. Additionally, there are health and safety, authorization basis, and security requirements, and constricted schedules and budgets.

The deployment of the EMWD/HDD system at RFETS will build on previous experience at Hanford and SRS. At RFETS, the system will be deployed at two sites – UBC 123 and Building 886 (Figure 1-1).

1.1 Purpose

This Sampling and Analysis Plan (SAP) details the sampling and analysis activities to be performed at UBC 123 and Building 886 in support of RFETS 2006 Closure. The purpose of this SAP is threefold:

1. To implement and test a new technology, EMWD/HDD, and determine its effectiveness in UBC characterization at RFETS. Data collected from soil samples along a horizontal profile will be qualitatively compared to data collected by vertical profile characterization techniques. This assessment will be used to determine the potential for EMWD/HDD characterization at future sites around RFETS and at other DOE facilities.

2. To determine the presence or absence of radioactive and/or hazardous contamination in the soils beneath UBC 123 associated with leaks adjacent to selected process waste lines, sumps, pits, waste pumping stations; localized spills beneath the concrete slab; and the general condition of the subsurface area beneath Rooms 101 and 103 of Building 886. Data generated is intended to be valid and useable for future remedial decisions.

12

3. To determine the cost effectiveness of EMWD/HDD characterization techniques compared to vertical drilling and sample collection methods. In addition to a cost per foot analysis, this comparison will also include other costs incurred in utilizing each method including additional planning, accessibility within buildings, health and safety issues, radiological engineering and controls, etc.

Implementation of this project will be performed in accordance with applicable federal, state, and local regulations, as well as DOE Orders, RFETS policies and procedures, and Environmental Restoration (ER) Operating Procedures (OPs).

Field activities planned under this SAP include drilling, field measurement, and soil sampling activities associated with EMWD/HDD and Geoprobe drilling. This project will couple the EMWD/HDD technology with additional monitoring techniques and provide DOE with the opportunity to test EMWD/HDD under standard Site operating conditions. A successful deployment of the EMWD/HDD technology at RFETS may result in data that can be used to: 1) make remedial decisions, 2) increase health and safety performance, 3) lower characterization costs, 4) accelerate schedules, and 5) better define the scope of the remediation for UBC 123 and Building 886. The technology would be directly transferable to other DOE sites.

The objective of this SAP is to define specific data needs, sampling and analysis requirements, data handling procedures, and associated Quality Assurance/Quality Control (QA/QC) requirements for this project. All work will be performed in accordance with the Kaiser-Hill Team Quality Assurance Program (K-H, 1999).

2.0 ENVIRONMENTAL MEASUREMENT-WHILE DRILLING (DATA COLLECTION SYSTEM)

The HDD process is not a new technology but has been used commercially in the oil and underground utility business for years. The EMWD is an innovative technology developed by Sandia which when coupled with the HDD process provides a secondary down-hole tracking mechanism for borings and real-time monitoring of gamma emitting radionuclides. The EMWD gamma calibration and field measurement procedures are included as Appendix A. Appendix B describes the HDD/EMWD drilling equipment.

3.0 BACKGROUND AND SITE HISTORY

3.1 UBC 123

UBC 123 is located on Central Avenue between Third and Fourth Streets in the RFETS Industrial Area (IA) (Plate 1), and consists of the Building 123 slab, soil, Individual Hazardous Substance Site (IHSS) 148, and all underground process systems (IHSS 121). The building footprint is approximately 18,444 square feet. Building 123 went into service in 1953 and housed the Radiological Health Physics Laboratory which analyzed water, biological materials, soil, air and filter samples for the presence of plutonium, americium, uranium, alpha radiation, beta radiation, gamma radiation, tritium, beryllium, and organics. Additionally, personnel radiation badges were counted and repaired. Low-level liquid and chemical wastes were generated at this location and transferred to treatment systems via the

/3

process waste lines system. The process waste systems at this location consist of underground pipelines composed of steel, polyethylene, cast iron, and other materials, sumps, and pumps. Potential contaminants of concern (PCOCs) beneath the slab are uranium, plutonium, cesium, metals, and volatile organic compounds.

The decontamination and decommissioning (D&D) of Building 123 and the surrounding area was completed in 1998. The project included the removal of Buildings 123, 123S, 113, 114. The Building 123 floor slab was sampled to assess potentially contaminated areas. Areas of the slab that could not be decontaminated to unrestricted release were encapsulated with epoxy paint to fix any removable contamination and covered with steel plate. The building slab and process waste lines were left in place. Several source storage pits of various dimensions were used to store radioactive sources and are also present under the slab. All of the pipelines were grouted at the slab level.

UBC 123 was chosen for deployment of EMWD/HDD because the slab is easily accessed. There are numerous underground utilities in the vicinity, but compared to other RFETS buildings, the underground layout should be relatively uncomplicated.

3.1.1 Original Process Waste Lines

IHSS 121 consists of the OPWL system which includes the plant-wide process waste system comprised of tanks and underground pipelines constructed to transport and temporarily store process wastes from point of origin to on-site treatment and discharge points. At UBC 123, IHSS 121 includes specifically process waste lines P-1, P-2, and P-3. These waste lines were described in the *Final Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan For Operable Unit 9* (DOE 1992a) and in the *Historical Release Report* (HRR) (DOE, 1992b).

All process waste generated in the early history of Building 123 was transferred to Building 441 through line P-2 and a series of manholes, which ran below grade under the east wing of Building 123 before exiting at the southeast corner of the building. P-2 was installed in 1952 and consisted of a 4-inch cast iron pipe with a total length of 452 feet. In 1968, the east wing of the building was extended approximately fifty (50) feet to the south. Prior to the building addition, two new manholes (MH-2 and MH-3, Plate 2) were constructed and the OPWL was extended south to MH-2, then east to MH-3, and north to MH-4, before assuming the original path at P-2. This extension was designated as P-3, which was installed in 1968. P-3 consists of a 4-inch vitrified-clay pipe with a total length of 162 feet. One original manhole was abandoned in place and covered by the building addition. In 1972, a west wing was constructed, extending south from the northwest corner of the original building. Line P-1 was installed at this time to transfer waste from three sumps, (Rooms 156, 157 and 158) and tie into the existing waste lines of P-2/P-3 at MH-2. A new manhole was added to waste line P-1 directly south of the west wing and designated as MH-1. The process waste lines transferred the following wastes from Building 123:

- **Acids:** nitric acid (HNO_3), hydrofluoric acid (HF), sulfuric acid (H_2SO_4), hydrochloric acid (HCl), acetic acid ($C_2H_4O_2$), and perchloric acid ($HClO_4$);

- **Bases:** ammonium hydroxide (NH_4OH) and sodium hydroxide (NaOH);

14

- **Solvents:** acetone, alcohols, cyclohexane, toluene, xylenes, triisooctomine, and ether;
- **Radionuclides:** various isotopes of plutonium (Pu), americium (Am), uranium (U), and curium (Cm);
- **Metals:** beryllium (Be) (trace amounts); and
- **Others:** ammonium thiocyanate, ethylene glycol, and possible trace amounts of polychlorinated biphenyls (PCBs) (DOE 1992a).

In 1974, P-2 and P-3 waste lines were abandoned and plugged with cement. No history exists regarding the flushing of these lines before abandonment. Within the same year, additional above grade piping was installed in Building 123 which connected the waste pumping stations (WPS-1 through 6) to the three sumps in Rooms 156, 157 and 158. In 1989, the process waste transfer system was upgraded. The P-1 piping, exterior to the west wing of Building 123, extending to MH-2 was removed. This piping was replaced with a double contained system from the building to Valve Vault 18. Process waste was transferred through P-1 to Valve Vault 18, then to underground Tank T-2 (Tank 853) at Building 428, and finally to Building 374 for treatment (Plate 2).

In 1998, the pipe chases and sumps from Rooms 125, 156, 157, and 158 were flushed with a trisodium phosphate/sodium carbonate decontamination solution during D&D of Building 123. No contaminants of concern were found to exceed Rocky Flats Cleanup Agreement (RFCA) Tier II action levels (ALs) in the associated final rinsates except for lead (56 ppb) from the sump in Room 125 (RMRS, 1998b).

3.1.2 IHSS 148

The eastern wing of Building 123 is encompassed by IHSS 148 which was part of Operable Unit (OU) 13. The Final Phase I RFI/RI Work Plan for Operable Unit 13, 100 Area (DOE, 1992c) described proposed characterization plans for IHSS 148. Characterization of OU 13 was conducted from September 1993 to February 1995 and the results were documented in the Draft Data Summary 2, Operable Unit No. 13, 100 Area (DOE, 1995).

Thirty-four analytes were detected in the surface soil samples, including twenty-six inorganic compounds and eight radionuclides. Eleven analytes exceeded background concentrations at a minimum of one sample location throughout IHSS 148. Constituents that exceeded background concentrations are listed in Table 3-1.

A soil-gas survey was conducted on a 25-foot grid in accordance with the OU-13 RFI/RF Work Plan (DOE 1992c) and samples were analyzed in the field using Gas Chromatography/Mass Spectrometry (GC/MS). Sixty-four soil-gas locations were sampled during the survey. Thirteen samples contained volatile organic compound (VOC) levels in excess of the 1 microgram per liter (μg/L) method detection limit. Benzene, toluene, ethylbenzene, and xylene (BTEX) fuel constituents were detected in samples collected from the perimeter of Building 123 and within the east and west wings of the building. Trichlorofluoromethane (TCFM) was detected in nine samples distributed throughout the IHSS 148 area at levels up to 2.6 μg/L. Tetrachloroethene (PCE) was detected at 1.5 μg/L in a sample collected east of Building 123. The presence of organic extraction constituents is consistent with

15

unconfirmed reports that liquids used in radionuclide analyses were occasionally disposed onto the soil surface outside of Building 123 and allowed to evaporate. The soil-gas analytical results indicate that a potential for residual subsurface VOC contamination of soils exist at UBC 123.

Unconfirmed reports of contaminant spills have been indicated in interviews with building employees. In the late 1960's or early 1970's a cesium-contaminated liquid was reportedly spilled on the concrete floor in Room 109. The floor was immediately sealed to immobilize the contamination. Room 109 also had source storage pits (SPs) in it. Undocumented thorium research was performed in Room 105. Scoping surveys conducted in May through July 1997 revealed elevated levels of radioactivity in both Room 105 and 109. In-situ gamma spectroscopic measurements performed in August 1997 indicated the presence of cesium-137 and thorium-232 in Rooms 109 and 105, respectively (RMRS, 1998b).

Four associated Potential Areas of Concern (PACs), 100-601, 100-602, 100-603, and 100-611, have been identified as associated with UBC 123, as shown in Plate 1. The PACs were established as the result of documented spill incidents. PAC 100-601 was approved as a No Further Action (NFA) site in 1992.

3.1.3 Resource Conservation and Recovery Act (RCRA) Unit 40

The UBC 123 area includes RCRA Unit 40, which consisted of active overhead process waste lines, P-1, and three sumps in Rooms 156, 157 and 158 in the western part of Building 123. RCRA Unit 40 underwent decommissioning as part of the Building 123 D&D (Appendix C) but has not yet been closed.

3.2 Building 886

Building 886, located in the northeastern portion of the 800 Area, was commissioned into service in 1965 (Plate 3). In approximately 1980, Trailer 886A was built immediately east of the building and was later connected by the existing breezeway. Building 886 housed the Critical Mass Laboratory where low-level criticality experiments were performed on liquids, powder, and solid forms of fissionable materials. The building currently houses offices and a small electronics/machine shop. Enriched uranium solutions, solid enriched uranium, and plutonium metal have been used in this building. The building footprint is approximately 14,197 square feet. Highly enriched uranyl nitrate (HEUN) solutions were spilled in Rooms 101 and 103. Room 103 contained 7 HEUN tanks and a tank storage pit. Various utilities are beneath the building slab and two buried pits are just west of the building. The date of the last criticality experiment was in October 1987.

Reconnaissance-Level Characterization (RLC) studies were conducted and focused on the identification of potential sources of chemical contamination within the building. The hazards identified during the RLC were physical and chemical (i.e., lead and metals, PCBs, and asbestos). Potential radiological contamination has not yet been fully characterized (RMRS, 1999b).

IHSS 164.2, Radioactive Site #2, 800 Area, Building 886 Spill, surrounds Building 886 and is the result of a previous release of an unknown colorless liquid from a 500-gallon tank onto the concrete slab. Surface soils in IHSS 164.2 were sampled during the RFI/RI for Operable Unit 14. Results indicated that uranium-238 was above background values at locations north, south, east, and west of

16

Building 886; plutonium was above background values north and east of the building; and americium-241 was above background east of Building 886 (DOE, 1995). Building 886 has no process waste lines directly underneath, however a few exist, along with a foundation drain for surface water, west of the building. These process waste lines and foundation drain are not within the scope of this project.

3.3 Geologic Setting

UBC 123 and Building 886 are situated on a gently eastward sloping topographic and bedrock pediment surface mantled by unconsolidated Rocky Flats Alluvium and underlain mainly by claystones and siltstones of the Cretaceous Laramie Formation (EG&G, 1995a). The Rocky Flats Alluvium is composed of poorly to moderately sorted clay, silt, sand, and gravel. Both UBC 123 and Building 886 are in an IA that has been gradually developed. The native soils have been disturbed and replaced by fill during installation of the OPWLs and covered by pavement and structures.

3.3.1 UBC 123

The average depth to groundwater is estimated to range from 2 to 6 feet in the UBC 123 area. (EG&G, 1995b). Water table fluctuations have ranged up to 6.5 and 9.7 feet as recorded in nearby wells 10498 and 10198 (1998-1999 data), with a seasonally high depth to water of 3 to 6 feet below ground level. Currently monitored wells around Building 123 are 10098, 10198, 10298, 10398, 10498 and 10598 as shown on Plate 2. These wells were installed after D&D activities in 1998. Fourth quarter 1998 groundwater results indicate that metals analyses exhibited no results above RFCA Tier II Als. VOCs and radionuclides were slightly above Tier II in several places. The Tier II exceedances are well below Tier I ALs and are listed below (RMRS, 1999c).

- Monitoring well 10498, sampled on 8/12/98, PCE result of 15 μg/L, $U^{233/234}$ result of 1.41 picocuries per liter (pCi/L), and U^{238} result of 1.22 pCi/L;
- Monitoring well 10098, sampled on 8/10/98, $U^{233/234}$ result of 1.13 pCi/L, and U^{238} result of 1.08 pCi/L; and
- Monitoring well 10298, sampled on 8/11/98, $U^{233/234}$ result of 1.08 pCi/L, and U^{238} result of 1.10 pCi/L.

3.3.2 Building 886

Building 886 is situated in the Rocky Flats Alluvium which ranges from about 6.4 feet at well P317989, located approximately 180 feet southwest of the building, to about 9 feet at well 22996, located approximately 100 feet east of the northeast corner of the building. The depth to groundwater (2nd quarter 1997 data) ranges from 3.5 feet at well P317989 to 6.15 feet at well 22996 resulting in an alluvial saturated thickness of 2.9 feet. Building 886 was constructed with a foundation drain to route surface water along the west side of the building (RMRS, 1999d). Periods of high groundwater elevations in the spring and/or heavy precipitation have historically resulted in numerous instances in which groundwater has seeped through the concrete of the Room 103 pit flooding the depressed room.

17

4.0 SAMPLING RATIONALE

This project is a demonstration of a new technology at RFETS. The effectiveness of the EMWD/HDD methods at sites currently undergoing decommissioning will be compared to traditional characterization techniques. It is expected that this demonstration will produce usable data for future remedial decisions. Data generated will be used in conjunction with previously collected data from UBC 123 and Building 886. The activities presented in this SAP are intended to complete final characterization at UBC 123 but will only provide a more limited, scoping characterization at Building 886. Historical information presented in Section 3 provides information on the PCOCs at UBCs 123 and Building 886. This information was used to develop a systematic sampling strategy for this investigation. Because of the complexity of UBC sites, at RFETS and at other DOE sites, new characterization technologies are needed to provide consistent and adequate data for remedial decisions as defined in Section 5.5.

4.1 UBC 123

Subsurface samples collected during the pre-remedial investigation (Section 3) provide only screening data, as they were composited over six feet of depth and were at least 10 feet away from process waste lines. A major component of this project is to characterize soil immediately adjacent to and below the process waste lines (i.e. within approximately a one to three foot range). The following conditions were considered in the development of the sampling strategy:

- The operating history of Building 123 suggests that VOCs, metals and radionuclides may have been released to the environment from subsurface (i.e., process waste line) sources;
- The physical and chemical properties of PCOCs suggest a chronic presence if released to the environment; and
- Previous surface and subsurface characterization efforts conducted in and around UBC 123 did not specifically focus on the potential releases from the OPWLs and NPWLs. Although numerous samples have been taken in the vicinity, additional sampling near these pipelines and associated systems is necessary to provide adequate characterization.

There are three process waste lines beneath UBC 123 - P-1, P-2, and P-3. Each of these pipelines is approximately five feet below the surface of the Building 123 slab. The proposed boreholes (HDD Lines 1, 2, 3, and 4) are shown in Plate 2 and are intended to characterize the soils immediately below P-1, P-2, and P-3 and other selected areas of interest. These areas include the sumps/pits of Rooms 125, 156, 157, and 158, process waste line intersections, and three connecting manholes.

4.2 Building 886

Historical information suggests that numerous spills of HEUN and other contaminants occurred within Room 101 and the 103 pit. Additionally, periods of high ground water and/or heavy rains produce groundwater seepage through the Room 103 pit floor into the room's interior that leaves traces of the HEUN when the water recedes. This suggests that liquid contaminants are present in the underlying soils and concrete slab.

The focus of the EMWD/HDD demonstration at Building 886 is to characterize the soil beneath the concrete slab of Rooms 101 and 103. Plate 3 illustrates the two proposed HDD lines (HDD Lines 5 and 6) located underneath the foundation trench of Room 101 and the pit area of Room 103. Additionally, Building 886 was chosen for deployment of EMWD/HDD because it is currently undergoing decommissioning, is easily accessible (i.e., not in the Protected Area), and represents health and safety and access challenges associated with inside building characterization similar to other industrial buildings. Areas of concern under the building may be more easily accessed by HDD than vertical drilling techniques. Deployment at Building 886 will provide valuable experience in assessing and mitigating issues associated with inside building characterization of UBC sites and provide substantial information on cost comparisons between HDD and conventional drilling techniques.

5.0 DATA QUALITY OBJECTIVES

The U.S. Environmental Protection Agency (EPA) has established a process for decision-making and developing Data Quality Objectives (DQOs). DQOs are designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application. Data requirements to support this project were developed and are implemented using criteria established in *Guidance for the Data Quality Objective Process*, QA/G-4 (EPA 1994).

The DQO process consists of seven steps and is designed to be iterative; the outputs of one step may influence prior steps and cause them to be refined. Each of the seven steps are described in the section below. The data and measurements collected from this investigation will be compared to the RFCA Tier I and II ALs to determine if remediation is necessary for the sites.

5.1 State the Problem

Previous investigations at RFETS have identified various types of contamination that have either been released to soils or leaked from various subsurface process lines and/or sumps. The purpose of this investigation is to determine the presence or absence of potential radiological and/or hazardous contamination in soils along the process waste lines (P-1, P-2 and P-3), connecting manholes (MH1-3), beneath three sumps, and six waste pumping stations of UBC 123 and beneath Rooms 101 and 103 of Building 886.

5.2 Identify the Decision

Decisions that will be made using data collected from implementation of EMWD/HDD measurements and the data collected from subsurface soil samples include:

- Do the subsurface soils beneath UBC 123 and Building 886 contain radiological and/or hazardous (VOCs, Semi-Volatile Organic Compounds [SVOCs], and metals) contamination above the RFCA Tier I or II ALs.

- Does the successful deployment of the EMWD/HDD technologies at RFETS provide consistent and accurate data for remedial decisions and reduce health and safety concerns, budgets, and schedules in a qualitative comparison to conventional drilling and characterization techniques? If not, what are the inhibiting factors?

5.3 Identify Inputs to the Decision

Inputs to the decision include radiochemical measurements from the EMWD/HDD and from the radiochemical and chemical analytical results from the soil samples collected from the deployment of HDD and vertical drilling methods. The contaminants of concern (COCs) will be determined by a comparison of the analytical data to the RFCA ALs.

Analytical data collected from previous soil characterization activities within and surrounding UBC 123 and Building 886 are presented in the *Final Pre-Remedial Investigation of Individual Hazardous Substance Sites (IHSS) 121 and 148 at Building 123 Data Summary Report, RF/RMRS-98-255.UN, Final Close-Out Report Building 123 Decommissioning Project, RF/RMRS-98-253.UN, Draft Data Summary 2, Operable Unit No. 13, 100 Area, and Draft Data Summary 1, Operable Unit No. 14, Radioactive Sites* will be considered as inputs to the decision. The soils beneath Building 886 have not yet been characterized.

Based on process knowledge and previous investigations, PCOCs at UBC123 include the following:

- Metals
  - Aluminum
  - Chromium
  - Copper
  - Lead
  - Nickel
  - Potassium
  - Strontium
  - Zinc

- Organics
  - Acetone
  - Benzene
  - Ethylbenzene
  - Tetracholroethene
  - Toluene
  - Trichlorofloromethane
  - Xylene

- Radionuclides
  - Americium^{241}
  - Cesium^{137}
  - Plutonium$^{239/240}$
  - Uranium^{234}
  - Uranium^{238}

20

Based on process knowledge and previous investigations, PCOCs at Building 886 include the following:

- Metals
  - Copper
  - Magnesium
  - Mercury
  - Strontium
  - Zinc

- Radionuclides
  - Americium^{241}
  - Plutonium$^{239/240}$
  - Uranium^{234}
  - Uranium^{235}
  - Uranium^{238}

Additional inputs to the decisions include the following:

- Method detection limits (below RFCA Tier II ALs)/practical quantitation limits;

- Background concentrations for each inorganic and radionuclide PCOC;

- RFCA Tier I and Tier II ALs for surface soil, and subsurface soil as listed in the Action Levels and Standards Framework for Surface Water, Ground Water, and Soil (ALF) (RFCA, Attachment 5). Comparison criteria include the following:

  a) Each soil data value will be compared to the appropriate AL; and

  b) Each soil data value will be compared to the background mean plus two standard deviations.

5.4 Define the Boundaries

The investigative boundaries for this project are the surface and subsurface soils found within IA Groups 100-4 and 800-4. IA Group 100-4 includes UBC 123, IHSS 148, RCRA Unit 40 and PAC 100-603. IA Group 800-4 includes UBC 886 and IHSS 164.20.

5.5 Decision Rules

The decision rules for this project describe how the data will be evaluated and are listed below.

1. If all analytical results are non-detections, then the PCOC will be disqualified from further consideration; otherwise, the PCOC will be retained.

21

2. If all data values are below the background mean plus two standard deviations, then no action is necessary.

3. If each data point is below the Tier II AL and the sum of the ratios of each soil data value to its respective Tier II ALs for both non-radionuclides and radionuclides are below 1, then no evaluation, management, or remediation of the IA Group is necessary.

4. If a single data point is above the Tier II AL or the sum of the ratios of a single soil data value to its respective Tier II ALs for either non-radionuclides or radionuclides are greater than or equal to 1, then evaluation, management, or remediation of the IA Group is necessary.

5. If a single PCOC data point is above the Tier I AL or the sum of the ratios of a single soil data value to its respective Tier I ALs for either non-radionuclides or radionuclides are greater than or equal to 1, the PCOC becomes a COC and additional data evaluation is necessary.

6. If the ratio of the 95% Upper Confidence Limit (UCL) of the mean concentration for a single COC to its Tier I AL or the sum of the ratios of the 95% mean concentrations for all COCs to their respective Tier I ALs for both radionuclides and non-radionuclides within an IA Group are greater than or equal to 1, an action will be taken according to RFCA requirements.

7. If the ratio of the 95% UCL of the mean concentration for a single COC to its respective ALs and the sum of the ratios of the 95% UCL of the mean concentrations for all COCs to their respective ALs for both radionuclides and non-radionuclides are greater than or equal to 1 for Tier II ALs and below 1 for Tier I ALs, then further evaluation of the site is required in accordance with RFCA requirements.

8. If the ratio of the 95% UCL of the mean concentration for a single COC to its Tier II AL and the sum of the ratios of the 95% UCL of the mean concentrations for all COCs to their respective Tier II ALs for both radionuclides and non-radionuclides are below 1, then the soil does not need to be further evaluated or managed per RFCA requirements. Otherwise, the soil needs to be further evaluated, managed, or remediated in accordance with RFCA requirements.

9. If the costs associated with the implementation of the HDD technology at RFETS outweigh the type, quality, and usability of the data it is able to generate, a recommendation will be made for the continued use of conventional, cost-effective sampling and measurement techniques; and

10. If the margin of error associated with the accuracy of underground HDD navigation is greater than the amount of certainty with which one can accurately locate below surface hazards and/or obstacles, an evaluation of this technology will be conducted prior to the further use of the EMWD/HDD system at RFETS.

5.6 Decision Limits

Additional characterization, if required, will be based upon an evaluation of data collected under this SAP. The sample locations are based on previous soil investigations, the location of potential contaminant releases OPWLs, and RCRA process lines. Soil sampling will be performed in accordance with this SAP and RFETS policies and procedures.

5.7 Optimization of Design

<u>Analytical Data</u>

In the event that further characterization is required to evaluate contaminant releases to the subsurface soils from UBC 123 or Building 886, the results of this investigation will be used to design additional field activities, such as selection of additional boreholes and soil sample locations and refinement of the analytical parameter suite. If data gaps are identified as the investigation progresses or subsequent to the collection of all samples as described, this SAP will be modified and additional samples will be collected as needed to adequately characterize the investigation area. Analytical data collected in support of this SAP will be evaluated using the guidance established in *Evaluation of Data for Usability in Final Reports* (RF/RMRS-98-200). Additional phases of field activity will be implemented under modifications to this SAP or under a separate SAP.

<u>EMWD-GRS</u>

If the EMWD-Gamma Ray Spectrometer (GRS) tool is able to accurately identify regions of gamma-emitting contamination in the subsurface as drilling is conducted, and as verified by the corresponding analytical results of the samples, EMWD/HDD implementation will be considered a useable means for UBC characterization. In the event that elevated down-hole GRS measurements are not confirmed by the analytical results of the soil samples, this portion of the SAP will be reevaluated. Possible scenarios in which this instance may occur may include but are not limited to:

- Refusal of borehole drilling due to obstructions;
- Inability to accurately navigate the HDD bit or Geoprobe sampler to the desired locations;
- Soil sample collection location is too far away from the GRS measurement area; and
- Insufficient sample recovery.

6.0 SAMPLING METHODOLOGY AND ACTIVITES

This section discusses the specific methodologies, activities, and procedures to be followed for field work and sample collection during this project. Table 6-5 identifies the analytical requirement for this project.

6.1 HDD Drilling Methodology

Horizontal drilling and sample collection will be conducted in accordance with procedure RMRS/OPS-PRO.114, *Drilling and Sampling Using Hollow-Stem Auger and Rotary Drilling and Rock Coring Techniques* and any procedures developed by the HDD subcontractor. Any additional HDD procedures will be reviewed and approved by the project staff prior to the start of work and provided as an Appendix to the Integrated Work Control Package (IWCP) following the award of the subcontract.

The following steps are general in nature to the HDD and sample collection process and do not describe every possible use or system available today:

1. Establish entry points and angles for horizontal boring;
2. Determine drill path;
3. Clear right of way and jobsite area;
4. Set up drilling rig on entry point and at proper entry angle; set up navigational steering system on both sides;
5. Mix appropriate drilling fluids as needed;
6. Initiate drilling of pilot hole while using above ground locator for guidance;
7. Drill pilot hole using down-hole navigation system, follow the proposed drill path and collect continuous gamma radiation and navigational data;
8. Stop horizontal boring one to two feet away from desired sample area. Trip out the drill string and remove the drill bit, steering mechanism, down-hole electronics, and connect the appropriate soil sampler (such as a core barrel) to the end of drill string;
9. Reinsert sampler into bore and continue to push it into undisturbed soil until the sample area is reached;
10. Retract drill string approximately 18 inches to lock sampler tub in the open position. Push (or core) the sampler forward, filling the tube with soil;
11. Using HDD bit tracking system, collect the coordinates (x, y, and z) at which the horizontal soil sample was collected and mark the location at the surface with a stake or paint;
12. Retract the drill string, remove sampler, and remove sample from sampler and handle/containerize the sample as specified in Section 6.6;
13. Repeat steps 7 through 12 as necessary; and
14. After pilot hole is complete and the required number of samples are obtained, trip out drill string, abandon borehole, demobilize rig equipment, and ensure job site is clean according to specifications.

The installation of casing may be required in order to keep the borehole open and clear of caving if drilling muds prove to be an ineffective means of doing so. If required, the casing will be of suitable size and material for soil sampling requirements and will be installed in a way as to not interfere with the EMWD-GRS measurements. Upon completion of the drilling and sampling, each borehole will be abandoned with grout of suitable composition in accordance with procedure RMRS/OPS-PRO.117. All casing within three feet of ground surface will be removed prior to abandonment. Project staff will determine whether or not to remove the rest of the installed casing or abandon it in place.

In order to position the drill bit at its desired depth and location and to achieve the intended trajectory for each lateral boring, the HDD rig will be positioned with an appropriate amount "layback" prior to drilling. Layback is referred to as the distance the rig is set back from the area of interest to position the drill bit in the desired location and is a function of the angle of the rig's horizontal ramp. During drilling, the bit location will be continuously monitored, adjusted and verified by the EMWD tracking survey and the bit location electronics package from the point of ground penetration throughout the layback distance and HDD line characterization boring. The soils drilled within the layback distance will not be sampled but will be monitored for radiological contamination by the down-hole GRS.

6.2 Geoprobe Drilling Methodology

A model 54LT track-mounted Geoprobe (or a similar, sized and equipped model) will be used to collect vertical profile soil samples along the five HDD lines and in other selected areas of interest detailed in Sections 6.4.2 and 6.4.4 and displayed in Plates 2 and 3. This type of Geoprobe was selected due to its versatility in maneuvering within the tight confines of buildings and will be used at both building sites. The methods and procedures for Geoprobe use and sample collection for this project are discussed in Section 6.6.2. No in-situ gamma measurements will be collected during Geoprobe sampling.

6.3 Pre-Drilling Activities

In preparation for drilling and associated field activities, a contamination area (CA), radiological buffer area (RBA), support zones and all related radiological postings will be established and identified at each borehole work site in accordance with the project specific Health and Safety Plan(s) (HASP) and Radiological Safety Procedure (RSP). The HDD drill rig will be equipped with the appropriate materials for containing drill muds and cuttings as well as secondary containment means for keeping any potential spill, leaks or splashes from coming in contact with the surrounding soils. Before advancing boreholes, all locations will be cleared in accordance with RMRS/OPS-PRO.102, *Borehole Clearing*, and marked in accordance with RMRS/OPS-PRO.124, *Push Subsurface Soil Sampling.* A pre-work radiological survey will be conducted in accordance with 5-21000-OPS-FO.16, *Field Radiological Measurements*.

All necessary Health and Safety (H&S) protocols will be followed in accordance with the project specific HASP(s) addenda, and IWCP, as appropriate. A Readiness Review will be conducted before the commencement of any fieldwork. All work will be conducted under applicable Radiological Work Permits (RWP), prepared by Radiological Engineering, that will be designed specifically for each type of field activity.

6.4 Sample Locations and Frequency

The sampling events will focus on the soil underlying OPWLs and NPWLs at UBC 123 and the foundation and slab of Rooms 101 and 103 of Building 886. This section details the specific borehole and sample collection locations and frequencies. Many of the sampling locations specified in this section and Tables 6-1 through 6-4 are biased to be positioned within the downgradient (generally eastern) areas of the regions of interest (i.e., the OPWLs, pits, and waste processing stations of UBC 123).

Tables 6-1 through 6-4 detail the specifications of each HDD and Geoprobe soil sample location. QA/QC samples will be collected in locations determined by the field supervisor at the time of sample collection in accordance with the QA specifications presented in Section 9.0.

Modifications to this SAP may be made by project management or the field supervisor prior to and/or during field activities. Modifications will be documented in the designated field logbook, sample documentation, and justified in the final report. Reasons for modifying the SAP may include but are not limited to the following uncertainties:

- Margin of error associated with the accuracy of locating underground utilities and/or structures;
- Unanticipated impact with or breaching of a known or unknown underground object or utility;
- Refusal of drill bit progression or sampling capabilities due to impact with unidentified obstacles in boreholes;
- Elevated GRS activity levels observed down-hole;
- Equipment and tool limitations, failures, or malfunctions; and
- H&S issues.

6.4.1 UBC 123 HDD Samples

Four HDD boring line locations (HHD Lines 1-4) have been chosen for characterization of the soils immediately beneath and along the process waste lines, manholes, and sumps of UBC 123 as described in Section 3.1. Plate 2 illustrates the location of the proposed HDD lines, soil sample locations and relationships to UBC 123 and surrounding features.

The available historical data, engineering drawings and as-built diagrams indicate that each of the process waste lines are buried approximately five feet below surface grade, but the accuracy of these figures and locations cannot be verified. Additionally, previous subsurface investigations in this area have uncovered additional utilities and structures not shown in the drawings. Many of these structures have not been clearly identified as to their nature, extent, or intended use. Kaiser Hill Excavation Specialists will implement the use of Ground Penetrating Radar (GPR) and other survey instruments to locate, as reasonably possible, all subsurface utilities and structures prior to the commencement of drilling and in preparation for an Activity Hazards Analysis (AHA) and Pre-Evolution meetings. Site walk-downs and inspection within the existing manholes will also be conducted.

HDD entry points and borehole navigation may be modified and/or offset as a result of underground uncertainties and drilling difficulties. It will be necessary to maintain the integrity of the borehole annulus while tripping the drill string in and out for sampling. Depending on the success of keeping the borehole clear of slough, the four HDD lines may need to be drilled from either end of the borehole to adequately access the desired locations (i.e., drill from both ends of any given HDD line to complete a single borehole). Each borehole will be navigationally drilled and the associated soil samples will be collected as close as achievable to the process waste lines and other areas of interest. Final depths and horizontal boring extent determinations will be made in the field based on actual drilling capabilities, obstructions, and professional judgement. The lengths of HDD lines described below represent lengths within which soil sampling will be conducted and do not represent the associated layback distances required for each borehole.

<u>HDD Line 1</u>

HDD Line 1 will be drilled beneath and along RCRA Unit 40 P-1 to MH-1 in a north/south orientation and will be approximately 110 feet long extending from the center of the pit in Room 156 south along P-1 to MH-1. Seven soil sampling locations (HDD-1-01 to 07) are proposed along this borehole. Sampling locations will be spaced approximately 15 to 20 feet apart with minor adjustments made to collect samples in specific areas of interest. These areas include the three sumps of Rooms 156, 157, and 158 along P-1 and the intersection of P-1 and MH-1 (see Plate 2). According to the as-built drawings, the depths of the sumps in Rooms 156, 157, and 158 are 4 ft. 2 in., 5 ft., and 5 ft. 3 in. below ground surface (bgs), respectively.

The HDD Line 1 borehole will be drilled to a position just below and to the east along P-1, approximately 6 feet bgs. Entry to the ground will be initiated through the concrete slab just north of the Room 156 sump.

<u>HDD Line 2</u>

HDD Line 2 will be drilled beneath and along OPWL and NPWL P-2 in a north/south orientation and will be approximately 190 feet long. This borehole will extend from the northern footing of the Room 107A area south to the intersection of P-3 with the waste lines P-1 near MH-2. This borehole will run parallel to the eastern wing of the building and will be situated approximately 6 to 7 feet east of the western edge of the wing. Thirteen soil sampling locations (HDD-2-01 to 13) are proposed along this borehole. Sampling locations will be spaced approximately 15 feet apart with minor adjustments made to collect a sample (HDD-2-06) beneath WPS-1 of Room 125.

<u>HDD Line 3</u>

HDD Line 3 will be beneath process waste lines P-1 and P-3, and MH-1, -2, and -3 in an east/west orientation and will be approximately 150 feet long. This borehole will extend from approximately 3 feet west of MH-1 east to MH-3. Eleven soil sampling locations (HDD-3-01 to 11) are proposed along this borehole. Sampling locations will be spaced approximately 15 feet apart with minor adjustments

27

made to collect samples in specific areas of interest. These areas include the regions just west (upgradient) of the intersection of P-1 with MH-1 (HDD-3-01) (within PAC 100-603), just east (downgradient) of MH-1 (HDD-3-02), just east (downgradient) of the intersection of P-1, P-3, and MH-2 (HDD-3-07), and just east (downgradient) of the intersection of P-3 with MH-3 (HDD-3-11).

HDD Line 4

HDD Line 4 will be drilled beneath OPWL P-2 along Rooms 111, 112, 113, 119A, 119, and 122 in an east/west orientation and will be approximately 85 feet long. This borehole will extend from the northwest corner of Room 111 east to the point where P-2 turns south in the northwestern region of Room 122. Six soil sampling locations (HDD-4-01 to 06) are proposed along this borehole. Sampling locations will be spaced approximately 15 to 20 feet apart as shown on Plate 2.

6.4.2 UBC 123 Geoprobe Samples

After horizontal borehole drilling and sample collection beneath UBC 123, vertical Geoprobe soil sampling will be conducted at the locations shown on Plate 2 and as described in Table 6-2 and below. Sample depths are estimated and the actual depths of OPWLs, sumps, and other areas of interest will dictate the actual sample intervals. Geoprobe sample locations will be positioned to correspond to approximately 40 to 50 percent of the HDD soil samples. In addition, vertical cores will be collected from several other areas of interest in which contamination is suspected to be or would likely be present. Along HDD lines 1-4, samples will be collected from the same depths and locations as the associated horizontal soil sample. Each Geoprobe sample location will be given a sample name (i.e., GP-) specific to that location and which corresponds to a specific location and Report Identification Number (RIN)/Event number. Each sample interval will be approximately two feet in length.

HDD Line 1

Four Geoprobe soil samples will be collected along HDD Line 1 as detailed in Table 6-2. These four locations include the three sumps in Rooms 156, 157, and 158 and MH-1. The soil intervals are as follows:

1. Geoprobe sample GP-1-01 will collocate sample HDD-1-01 at the Room 156 Sump with a collection interval of approximately three feet two inches to five feet two inches bgs;

2. Geoprobe sample GP-1-03 will collocate sample HDD-1-03 at the Room 157 Sump with a collection interval of approximately four feet to six feet bgs;

3. Geoprobe sample GP-1-04 will collocate sample HDD-1-04 at the Room 158 Sump with a collection interval of approximately four feet three inches to six feet three inches bgs; and

4. Geoprobe sample GP-1-07 will collocate sample HDD-1-07 with a collection interval of approximately one foot above to one foot below the HDD-1-07 sample depth at MH-1.

28

HDD Line 2

Six Geoprobe soil samples will be collected along HDD Line 2 as detailed in Table 6-2. The soil intervals are as follows:

1. Geoprobe sample GP-2-01 will collocate sample HDD-2-01 at the northern edge of Room 107A;
2. Geoprobe sample GP-2-04 will collocate sample HDD-2-04 at the above ground P-1 and the below ground P-2 intersection at Room 123;
3. Geoprobe sample GP-2-06 will collocate sample HDD-2-06 at the Waste Pumping Station P-1 in Room 125;
4. Geoprobe sample GP-2-08 will collocate sample HDD-2-08 in the Room 126 area;
5. Geoprobe sample GP-2-10 will collocate sample HDD-2-10 in the Room 128 area; and
6. Geoprobe sample GP-2-13 will collocate sample HDD-2-13 at the southern edge of Room 144/146 boundary.

HDD Line 3

Five Geoprobe soil samples will be collected along HDD Line 3 as detailed in Table 6-2. The soil intervals are as follows:

1. Geoprobe sample GP-3-01 will collocate sample HDD-3-01 approximately 3 feet west (upgradient) of MH-1 within the boundaries of PAC 100-603;
2. Geoprobe sample GP-3-04 will collocate sample HDD-3-04 approximately half way between MH-1 and MH-2;
3. Geoprobe sample GP-3-07 will collocate sample HDD-3-07 approximately 10 feet east (downgradient) of MH-2;
4. Geoprobe sample GP-3-09 will collocate sample HDD-3-09 approximately half way between MH-2 and MH-3; and
5. Geoprobe sample GP-3-11 will collocate sample HDD-3-11 at MH-3.

HDD Line 4

Three Geoprobe soil samples will be collected along HDD Line 4 as described in Table 6-2. The soil intervals are as follows:

1. Geoprobe sample GP-4-01 will collocate sample HDD-4-01 in the northwest corner of Room 111;

2. Geoprobe sample GP-4-04 will collocate sample HDD-4-04 in the Room 113 area; and

3. Geoprobe sample GP-4-06 will collocate sample HDD-4-06 in the northwest corner of Room 122 where P-2 turns south.

Additional Areas of Interest

Additional areas of interest have been selected around the UBC 123 for vertical soil sample collection. Historical documentation, interviews, and engineering drawings were the primary resources used in selecting these areas. These areas include waste pumping stations, pits, drains, sumps, fixed contamination areas, and source storage pits. The areas chosen for Geoprobe soil sampling are displayed on Plate 2. Each location will be sampled with a Geoprobe using a core barrel as specified in procedure RMRS/OPS-PRO.124, *Push Subsurface Soil Sampling*. The general methodology to be used in sampling these areas of interest is as follows:

1. Locate the area of interest and select a sampling point that will best represent the subsurface conditions. If possible, a location that is immediately east (downgradient) of the area will be selected;

2. If the desired location exists beneath the existing building slab, core through the slab using the appropriate tool just until the underlying soil is exposed;

3. If the area of interest is less than two feet bgs, collect the surface soil interval (approximately zero to two feet in depth) and collect the composite and grab samples as required (Section 6.6). If not, skip this step and proceed to step 4;

4. Push the sampler down to approximately one-foot above the depth of interest (predetermined from engineering drawings and process knowledge);

5. Collect a soil sample interval that bounds the depth of interest from one foot above to one foot below;

6. Collect the composite and grab samples as required; and

7. Abandon boring as required (see Section 6.6).

The additional areas of interest to be sampled at UBC 123 are:

- Waste Pumping Stations (WPS-1 through -6);
- Three source storage pits (SP-1 to SP-3) in Room 109 (covered by bolted steel plates overlying fixed contamination in the concrete slab);
- One source storage pit (SP-4) in Room 109B (grouted in place); and
- Room 105 Laboratory (Lab-1 and -2).

WPS-1 through -6 are located around the northern half of the building. WPS-2, -3, and -4 were above ground pumping stations and WPS-1, -5, and -6 were below (or partially below) ground pumping stations contained within secondary containment concrete pits. SP-2, -3 and -4 are referred to as Type B source pits. Each of these three pits is vertically encased by a twelve-inch diameter steel pipe to a depth of sixteen inches below the concrete slab. SP-1 was a Type C source pit, the specifics of which are currently being investigated. The specific sampling depths and frequencies for these areas are detailed in Table 6-5. In addition to the sample analysis suite presented in Table 6-5, the Geoprobe soil samples collected at SP-1 through SP-4 will also be analyzed for $Cesium^{137}$. Lab-1 and Lab-2 will be collected in response to unconfirmed spills in the Room 105 laboratory.

6.4.3 Building 886 Geoprobe Samples

Vertical profile soil samples will be collected from within Building 886 with a Geoprobe to further characterize the UBC and to make qualitative comparisons between the two sample sets. Professional judgment and the assessment of the actual physical conditions of the work site will be considered in determining the Geoprobe sampling locations and frequency. Some Geoprobe samples will collocate the horizontal samples while others will be positioned to gain more information on the subsurface conditions of Rooms 101 and 103 (Plate 3).

Geoprobe borings and sampling will take place within Room 101 to determine the levels of contamination in the sub-foundation soils prior to the drilling of HDD Line 6. This will be done as a precautionary measure in order to anticipate and prepare for elevated levels of contamination which could cross contaminate soil along the HDD boring or at the surface and point of entry.

HDD Line 6 and Room 101

Prior to the drilling of HDD Line 6, four Geoprobe samples will be collected within Room 101 as described in Table 6-4 and as follows:

1. Geoprobe sample GP-6-01 will collocate sample HDD-6-01 in the northeast corner of Room 101. Two soil intervals will be collected from GP-6-01. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second will bound the anticipated depth at which HDD-6-01 will be collected by one foot above to one foot below (estimated to be 2.5 to 4.5 feet below the slab).

2. Geoprobe sample GP-6-04 will collocate sample HDD-6-04 in the northwest corner of Room 101. Two soil intervals will be collected from GP-6-04. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second will bound the anticipated depth at which HDD-6-04 will be collected by one foot above to one foot below (estimated to be 2.5 to 4.5 feet below the slab).

3. Geoprobe sample GP-6-05 will not collocate any HDD Line 6 sample and will be located beneath the southeast corner of Room 101. Two soil intervals will be collected from this location. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second interval will start at the depth where the first interval ended and will extend to two feet below that depth.

4. Geoprobe sample GP-6-06 will not collocate any HDD Line 6 sample and will be located beneath the southwest corner of Room 101. Two soil intervals will be collected from this location. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second interval will start at the depth where the first interval ended and will extend to two feet below that depth.

HDD Line 5 and the Room 103 Pit

Geoprobe sampling within the Room 103 Pit will depend largely upon the success of the sampling conducted within Room 101. If the Geoprobe activities conducted in Room 101 indicate that sampling within the Room 103 Pit can be completed safely and without a significant risk of spreading contamination or permanently contaminating the Geoprobe, four samples will be collected vertically from within the interior of the Room 103 Pit. The four Geoprobe samples will be collected as described in Table 6-4 and as follows:

1. Geoprobe sample GP-5-02 will collocate sample HDD-5-02 located in the eastern most area of the pit. Two soil intervals will be collected from this location. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second interval will bound the depth at which HDD-5-02 was collected by one foot above to one foot below that depth.

2. Geoprobe sample GP-5-03 will collocate sample HDD-5-03 in the north central portion of the pit. Two soil intervals will be collected from this location. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second interval will bound the depth at which HDD-5-03 was collected by one foot above to one foot below that depth.

3. Geoprobe sample GP-5-05 will be positioned in the west central portion of the pit. Two soil intervals will be collected from this location. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second interval will start at the depth where the first interval ended and will extend to two feet below that depth.

4. Geoprobe sample GP-5-06 will be positioned approximately 10 feet south of GP-5-05 in the southern most area of the Room 103 Pit. Two soil intervals will be collected from this location. The first will be from the first contact with soil beneath the slab to two feet below that depth. The second interval will start at the depth where the first interval ended and will extend to two feet below that depth.

6.4.1 Building 886 HDD Samples

Two horizontal boreholes (HDD Line 5 and 6) will be drilled beneath Rooms 101 and 102/103 of Building 886 (see Plate 3). HDD Line 6 (Room 101) will be drilled and sampled before HDD Line 5 due to expected levels of contamination. The HDD boreholes will be initiated, with the appropriate amount of layback, in an east-west orientation from the east side of Building 886. Real-time GRS measurements will be collected continuously throughout the entire bore. However, if elevated readings of the GRS or indications of radiological or hazardous contamination in the drill cuttings are observed prior to the drill string accessing the area of interest, drilling will temporarily cease to collect extended

GRS measurements and additional soil samples for further characterization. Professional judgement and subsurface drilling conditions will be used in determining additional sampling locations.

Due to the likelihood of elevated radiological contamination in the soils beneath these rooms, it is possible that drilling may be stopped and the boreholes abandoned prior to the collection of all the HDD samples listed below. Radiological levels will be continuously monitored down-hole and at the surface throughout drilling and appropriate field work determinations will be made at that time.

HDD Line 5

HDD Line 5 will be drilled just beneath the eastern concrete footing of Room 102 (approximately three and a half to four feet below surface grade) and will extend to the western footing of the Room 103 Pit. The area of interest for soil sample collection of HDD Line 5 is just beneath the slab of the Room 103 Pit and Room 108 hallway. Actual sample depths along the borehole are estimated to be four feet below the finished floor elevation. The horizontally sampled intervals will be approximately two to three feet in length.

The four HDD soil samples will be collected at the following locations. Table 6-3 summarizes the sample collections specifications listed below:

1. HDD-5-01 will be collected just east (downgradient) of Room 103 beneath the Room 108 hallway;

2. HDD-5-02 will be collected in the northeastern portion of the Room 103 Pit;

3. HDD-5-03 will be collected in the north central portion of the Room 103 Pit; and

4. HDD-5-04 will be collected in the northwestern portion of the Room 103 Pit.

HDD Line 6

HDD Line 6 will be drilled horizontally along the northern portion of Room 101 from the east and will extend to the western footing at approximately 3 to 3.5 feet below grade. The area of interest for soil sample collection is between the room's concrete floor slab and base of the foundation footing. The concrete footing of the east wall is four feet thick with a five-foot thick base and has a depth of five feet below surface grade. In order to minimize the amount of layback the drill rig would require to clear the footing at the intended trajectory, the desired borehole depth will be attained by drilling through the foundation wall, above the footing, approximately 2.5 to 3 feet below surface grade.

The interior of Room 101 is approximately 40 feet long along the HDD Line 6 and four horizontal soil cores will be collected and sampled as described in Table 6-3 and below.

1. HDD-6-01 will be collected just inside of the eastern foundation wall below the trench in the slab;

2. HDD-6-02 will be collected approximately 10 feet west of HDD-6-01;

3. HDD-6-03 will be collected approximately 10 feet west of HDD-6-02, just north of the "doghouse" area; and

4. HDD-6-04 will be collected just inside the western foundation wall.

6.5 Sample Designation

Each sample will be assigned a unique number in accordance with the RFETS Analytical Services Division (ASD) procedure, *Identification System for Reports and Samples, ASD-003*. The RIN is used by the ASD to track and file analytical data and will be designated by ASD prior to sampling activities. The unique sample number will be broken down into the following three parts:

- The RIN;
- The Event Number; and
- The Bottle Number.

The RIN is a seven digit alphanumeric code starting with the year (e.g., "00" for the year 2000). The RIN will be followed by a dash "-" and then the event number. The event number is a three digit code, starting with "001" under the RIN, and will be sequential. Each typical sample location will have a unique event number under the RIN. QC samples will have unique event numbers to support a "blind" submittal to the analytical laboratories. The event number will be followed by a period "." and then by the sequential bottle number. The bottle number is a three digit sequential code, starting with "001", and will be used to identify individual sample containers collected at the same location and same event number.

In addition to the sample numbering scheme above, additional information will be collected with respect to each sample and recorded on the project logsheets. This includes:

- Sample type; and
- QC code.

QC Codes will include the following, as appropriate:

- REAL: Regular Sample; and
- DUP: Duplicate Sample.

A sample number will also be assigned to each sample collected for internal sample tracking. The block of sample numbers will be of sufficient size to include the entire number of possible samples (including QA samples) and location codes. In preparation for the final report, the ASD and project sample numbers will be cross-referenced with location codes.

34

An overview of the sampling and analysis is presented in this section along with a discussion regarding sample handling, equipment decontamination, personal protective equipment (PPE) evaluation, quality control sampling, and sample designation. The sample identification number will be documented on the field forms.

6.6 Sample Collection

The sample collection requirements and procedures for each sample event to be performed under this SAP are described in this section. If conditions are encountered during characterization activities which make the use of a sampling technique unsafe or inappropriate for the task at hand, the procedures specified in this SAP may be modified or replaced as long as the modification or replacement is justified and detailed in the sampling records and the resulting data is comparable and adequate to meet the objectives of the project.

Upon sample recovery, a Health and Safety Specialist (HSS) or Radiological Control Technician (RCT) will scan, if necessary, each sample with a Field Instrument for the Detection of Low Energy Radiation (FIDLER). Sample cores will also be monitored for VOCs with a Flame Ionization Detector (FID) or a Photoionization Detector (PID) in accordance with procedure RMRS/OPS-PRO.121, *Soil Gas Sampling and Field Analysis*. Upon the completion of each boring, the borehole will be abandoned using procedure RMRS/OPS-PRO.117, *Plugging and Abandonment of Boreholes*. If probe refusal is encountered before reaching the target borehole depth, the borehole will similarly be abandoned and an offset boring will be attempted within 3 feet of the original boring.

Equipment will also be monitored for radiological contamination during and after sampling activities. All sampling equipment will be decontaminated with a liquinox (or alconox) solution, and rinsed with deionized or distilled water, in accordance with Operating Procedure 4-S01-ENV-OPS-FO.03, *Field Decontamination Operations* and the project specific HASP. All other sampling equipment will include standard items such as chain-of-custody seals and forms, logbooks, etc. Field duplicates will be collected to represent at least 5% of the sample batch to provide adequate information on sample variability, as defined in *Guidance for Data Quality Objectives Process* (EPA, 1994), and in accordance with the procedures listed in Section 9.0.

All H&S protocols will be followed in accordance with the requirements specified in the HASPs and addenda (as appropriate) developed for this project. Upon the award of each subcontract, the subcontractor will provide a HASP specific to the scope of work they are to perform (i.e., HDD and Geoprobe work activities). Each HASP shall be developed under the guidance of and in accordance with applicable federal, state, local, and Site policies and procedures. Each HASP will identify all PPE, training, and air monitoring requirements as well as all other hazard assessments and controls specific to the work scope and the Site.

6.6.1 HDD Sample Collection

HDD sample intervals will be reached using an appropriately sized and equipped horizontal drilling rig in accordance with the drilling procedure developed by the subcontractor. Soil samples will be collected, as possible, at the depths and intervals specified in Section 6.4 and as described in the methodologies in Section 6.1. Every effort will be made to collect an undisturbed portion of the borehole to obtain accurate and representative data from each sampling event.

Each HDD sample will be collected in two to three foot lengths using an appropriate type of coring or push sampler to be specified by the drilling subcontractor and approved by project management. The size, length, and diameter of the sampling tool will be a function of the degree of uncertainty in accurately determining the locations of the OPWLs, NPWLs, and other underground utilities, and its effectiveness in successfully recovering RFETS soils. Taking this level of uncertainty into account, this interval length of sample will be more representative of the underground conditions along the process waste lines and building slabs than shorter sample intervals. If, however, the sampling tool proves to be ineffective in successful sample retrieval, an alternate tool may be substituted as actual drilling conditions dictate. The soil intervals will be separated from the core and placed into a stainless steel bucket and will be composited by hand using a stainless steel trowel. VOC samples will be collected as grab samples and not composited. The samples will be containerized in accordance with the specifications in Section 6.7, and shipped to an offsite laboratory for analysis. VOC grab samples will have minimal to no headspace as actual field and sample recovery conditions permit.

Throughout the HDD, the levels of gamma-emitting radionuclides within the UBC soils will be continuously monitored and recorded every twenty seconds by the EMWD instrument providing real-time data to operations at the surface. Additional samples may be collected if the down-hole GRS indicates elevated radiological conditions or if visible evidence (staining, odors, etc.) of contamination is present in drill cuttings.

6.6.2 Geoprobe Sample Collection

For vertical profile sampling, sample depths will be reached using a portable Geoprobe hydraulic ram in accordance with Site procedure RMRS/OPS-PRO.124, *Push Subsurface Soil Sampling*. Soil cores will be recovered continuously to the desired depth in two-foot increments using a core barrel as specified in this procedure. Soil intervals will be separated from the core and placed into a stainless steel bucket and the soil will be composited by hand using a stainless steel trowel. VOC samples will be collected as grab samples and not composited. VOC grab samples will be containerized to minimize the amount of headspace within the sample container as actual field and sample recovery conditions permit. Due to the unconsolidated nature of the local soils, any gravel recovered with the sample may be removed prior to recovery.

For sample locations beneath the building slabs, a pre-cut concrete core will be removed from the slabs before drilling starts. A rotary type, wet coring system (such as a Hilty DD-100 Corer) will be used to initiate boreholes through the slabs of UBC 123 and Building 886. This type of system is useful in containing contamination which may be present within the paint and/or concrete. It utilizes a portable stand, which is held to the floor surface by vacuum pressure supplied by a vacuum pump. The slurry produced by coring will be contained by a slurry collection system used in conjunction with a wet/dry shop vacuum. Thus, little or no airborne emissions will be produced during coring activities.

UBC 123 Geoprobe boring sample locations will be surveyed for location and elevation using Global Positioning System (GPS) equipment to ensure accuracy in data plotting. GPS will not be possible inside Building 886; manual measurements will be collected instead.

6.7 Sample Handling and Analysis

Samples will be handled and containerized according to *Operating Procedures Volume/Field Operations*, RMRS/OPS-PRO.069, *Containing, Preserving, Handling, and Shipping of Soil and Water Samples*. Transferring and shipping of samples will be performed according to procedure PRO-908-ASD-004, *On-Site Transfer and Off-Site Shipment of Samples.*

Samples sent offsite for analysis will require evaluation under 49 CFR 173, the U.S. Department of Transportation's (DOT) radioactive materials criteria of 2,000 pCi/g, total radioactivity. If radiological screening indicates levels above this threshold, samples may be analyzed on-site or transported to offsite laboratories in accordance with hazardous materials transportation shipping requirements. DOT radiological screening samples will be collected and assigned a unique sample designation as described in Section 6.5. In addition, radiological screening samples collected under this SAP will be sufficient to support the DOT shipping and offsite laboratory license requirements.

Table 6-5 indicates the analytical requirements for each sample. Samples will be submitted to an offsite, EPA-approved laboratory for analysis under a routine (30-day) result turnaround time. All soil samples collected under this SAP will be analyzed for the following analytes (the analytical suite):

- Isotopic Pu, Am, and U;
- VOCs;
- SVOCs;
- Total Metals; and
- pH.

In addition, a site-specific analysis for Cesium^{137} will be conducted at Geoprobe sample locations SP-1 through SP-4 beneath the Room 109 area of UBC 123. Thorium analysis on soil samples from beneath Room 105 (sample locations Lab-1 and Lab-2) will not be conducted. Interviews with past employees of Building 123 verified that a crucible containing residual, solid thorium broke on the floor of Room 105 in the late 1970s. The small, isolated spill was immediately swept up and the area was cleaned (Trice, 2000). During building D&D, the concrete slab in this area was scabbled to remove fixed contamination. Thorium analysis of the underlying soils is not necessary.

6.8 Equipment Decontamination and Waste Handling

Reusable sampling equipment will be decontaminated in accordance with procedure FO.03, *Field Decontamination Operations*. Decontamination waters generated during the project will be managed according to procedure RMRS/OPS-PRO.112, *Handling of Field Decontamination Water*. Horizontal drilling and Geoprobe rigs and equipment will be decontaminated between building locations and following project completion at the 903 Decontamination Pad in accordance with procedure RMRS/OPS-PRO.070, *Equipment Decontamination at Decontamination Facilities*. PPE will be disposed of according to procedure 1-PRO-573-SWODP, *Sanitary Waste Offsite Disposal Procedure*.

Residual soil will be handled in accordance with RMRS/OPS-PRO.128, *Handling and Containerizing Drilling Fluids and Cuttings*. Returned sample media will be managed in accordance with 1-PRO-079-WGI-001, *Waste Characterization, Generation, and Packaging*. In the event that hazardous, low-level, or mixed wastes are generated, project waste generators will package and manage the waste containers in accordance with Site procedures 4-F99-ENV-OPS-FO.23, *Management of Soil and Sediment Investigative Derived Materials* and 4-H46-ENV-OPS-FO.29, *Disposition of Soil and Sediment Investigation-Derived Materials*.

7.0 DATA MANAGEMENT

A project field logbook will be created and maintained by the project manager or designee in accordance with Site Procedure 2-S47-ER-ADM-05.14, *Use of Field Logbooks and Forms*. The logbook will include time and date of all field activities, sketch maps of sample locations, or any additional information not specifically required by the SAP. The originator will legibly sign and date each completed original hard copy of data. Appropriate field data forms will also be utilized when required by the operating procedures that govern the field activity. A peer reviewer will examine each completed original hard copy of data. Any modifications will be indicated in ink, and initialed and dated by the reviewer. Logbooks will be controlled by the project.

Analytical data record storage for this project will be performed by ASD. Sample analytical results will be delivered directly from the laboratory to ASD in an Electronic Disc Deliverable (EDD) and hardcopy format. The EDD will be archived in the Soil and Water Database (SWD). Hardcopy records of laboratory results will be obtained from ASD in the event that the analytical data is unavailable in EDD or SWD at the time of report preparation. Analytical results will be compiled into a sampling and analysis report. Field data will be captured in electronic format and archived in SWD. Borehole locations will be surveyed for elevation, northing and easting in state planar coordinates and will be entered into SWD.

8.0 PROJECT ORGANIZATION

Figure 8-1 illustrates the project organization structure. The project manager will be the primary point of responsibility for maintaining data collection and management methods that are consistent with Site operations. Other support organizations assisting with the implementation of this project are represented in the organizational chart.

Sampling personnel will be responsible for field data collection, documentation, containerizing, and transfer of samples for analysis. Documentation will require field logs and completing appropriate forms for data management and chain-of-custody shipment. The sampling crew will coordinate sample shipment for on-site and offsite analyses through the ASD personnel. The sampling manager is responsible for verifying that chain-of-custody documents are complete and accurate before the samples are shipped to the analytical laboratories.

9.0 QUALITY ASSURANCE

All components and processes within this project will comply with the *Kaiser-Hill Team Quality Assurance Program*, PADC-1996-00051 (K-H, 1999). The K-H QA Program is consistent with EPA quality requirements and guidelines. In general, the applicable categories of quality control are as follows:

- Quality Program;
- Training;
- Quality Improvement;
- Documents/Records;
- Work Processes;
- Design;
- Procurement;
- Inspection/Acceptance Testing;
- Management Assessments; and
- Independent Assessments.

The project manager will be in direct contact with the QA manager to identify and correct potential quality affecting issues. Field sampling quality control will be conducted to ensure that data generated from all samples collected in the field for laboratory analysis represent the actual conditions in the field. The confidence levels of the data will be maintained by the collection of QC and duplicate samples, equipment rinsate samples, and trip blanks.

Duplicate samples will be collected on a frequency of one duplicate sample for every twenty real samples. Rinsate samples will be generated at a frequency of one rinsate sample for every twenty real samples collected. Trip blanks will accompany each shipment of VOC samples generated for the project. Trip blanks will not be required for samples shipped only for radiochemical analysis. Samples for validation will be randomly selected and those which are not selected for validation will be verified. Table 9-1 provides the QA/QC samples and frequency requirements of QA sample generation.

Data validation will be performed according to ASD procedures. Analytical laboratories supporting this task have all passed regular laboratory audits by ASD.

9.1 Precision, Accuracy, Representativeness, Completeness and Comparability

Precision, Accuracy, Representativeness, Completeness and Comparability (PARCC) parameters are indicators of data quality. Analytical data that is collected in support of the EMWD/HDD will be evaluated using the guidance in procedure RF/RMRS-98-200, *Evaluation of Data for Usability in Final Reports*. This procedure establishes the guidelines for evaluating analytical data with respect to the PARCC parameters. The following paragraphs define these PARCC parameters in conjunction with this project.

39

9.1.1 Precision

<u>Analytical Data</u>

The precision of a measurement is an expression of mutual agreement among duplicate measurements of the same property taken under prescribed similar conditions. Precision is a measure of the reproducibility of results and is evaluated by comparing results from field duplicate samples with results from associated real samples. Precision will be evaluated quantitatively by using two functions. The most typical measure for non-radiological analyses is the relative percent difference (RPD) term, whereas, because of the stochastic nature of radioactivity, a statistical measure is better suited for evaluating radiological reproducibility. This measure is referred to as the duplicate error ratio (DER). The equations for evaluating these two measures is provided below:

$$RPD = \left[\frac{C_1 - C_2}{(C_1 + C_2)/2}\right]100$$

C_1 = first sample result (in terms of concentration)
C_2 = duplicate sample result (in terms of concentration)

$$DER = \left[\frac{C_1 - C_2}{\sqrt{\left(TPU_{c1}^2 + TPU_{c2}^2\right)}}\right]100$$

C_1 = first sample result (in terms of concentration)
C_2 = duplicate sample result (in terms of concentration)
TPU = total propagated uncertainty

The purpose of the field duplicate samples is to evaluate the precision of the field sampling process. The acceptable RPD limits for non-radiological field duplicate measurements are ≤ 30% for soil and ≤ 40% for water. At least 85% of all quality control samples are required to comply with the established precision, or RPD goals. Duplicate samples exceeding the RPD criteria indicate that samples do not comply with the DQO specifications, and require an explanation of the deficiencies and a determination if additional sampling is required. The acceptable DER limit for radiological field duplicate measurements is ≤ 1.96. Duplicate samples exceeding the DER criterion are interpreted as different at the 95% confidence level.

<u>EMWD-GRS</u>

Precision refers to the degree of mutual agreement among individual measurements and provides an estimate of random error. Precision will be established by calibrating the EMWD tool at the DOE Grand Junction Calibration Facility and by using RFETS external cesium-137 sources prior to the start of the deployment (Appendix A). The EMWD-GRS system collects data at a sufficiently high rate so that the drilling rate does not affect data quality in moderately to highly contaminated soils. If a radiological "hot spot" is encountered, the drilling rate can be reduced to provide sufficient radiation count statistics. As discussed in Section 9.2, random error is directly related to sample period, drilling rate (changing environments), and contamination levels (count rate). For greater precision at low contamination levels, the sample period must be increased and drilling rate reduced, if not stopped altogether.

9.1.2 Accuracy

Analytical Data

Accuracy is the degree of agreement of a measurement with an accepted reference or true value and is a measure of the bias in a system. The closer the measurement to the true value, the more accurate the measurement. All analytical data will be compared with the analytical method, and detection limit with the actual method used, and its detection limit for each medium and analyte to assess accuracy.

EMWD-GRS

Accuracy refers to the difference between the contamination readings and a reference standard. The resulting accuracy contains error variances from both the repeated contamination readings and the reference standard. The analytical reading from sampled soil will be the standard. The analytical reading is a single value number with error bars. The EMWD-GRS system readings are a function of contamination reading versus location and sample period. Ideally, the EMWD-GRS system would be exposed to soils with uniformly distributed contamination consistent with the small sample used in laboratory analytical measurement. These ideal conditions will not exist during this project's execution. Using the statistical nature of the gamma measurement process and the calibration process and procedures, a comparable accuracy will be established. Calibration procedures are listed in Appendix A.

9.1.3 Representativeness

Analytical Data

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point. Representativeness is a qualitative term that should be evaluated to determine whether samples are collected in such a manner that the resulting data appropriately reflect the contamination present. Typically the discussion of representativeness is limited to an evaluation of whether analytical results for field samples are truly representative of environmental concentration, or whether they may have been influenced by the introduction of contamination during collection and handling. This is assessed by evaluating the results of various blanks, specifically equipment rinsates. Representativeness is also accomplished by obtaining an adequate number of samples from appropriate spatial locations within the medium of interest. The actual sample types and quantities will be compared with those stated in Section 6, and organized by analytical suite. Deviation from the required and actual parameters will be justified.

EMWD-GRS

Representativeness refers to the degree to which the data accurately and precisely represent the conditions or characteristics of a given parameter. For this project, representativeness will be ensured by executing consistent data collection procedures, including reading locations, reading procedures, and data storage. Representativeness will also be ensured by using each method at its optimum capability to provide results that represent the most accurate and precise measurement each method is capable of achieving.

9.1.4 Completeness

Analytical Data

Completeness is a measure of the amount of valid usable data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. Usability will be determined by evaluation of the PARCC parameters excluding completeness. Those data that are validated and need no qualification, or are qualified as estimated or undetected, are considered usable. Rejected data are not considered usable. Completeness will be calculated following data evaluation. A completeness goal of 90% has been established for this project. If this goal is not met, additional sampling may be necessary to adequately achieve project objectives. Completeness is calculated using the following equation:

$$Completeness = DP_u = \left[\frac{DP_t - DP_n}{DP_t}\right]100$$

Where:
DP_u = Percentage of usable data points
DP_n = Non usable data points
DP_t = Total number of data points

EMWD-GRS

Completeness refers to the amount of data collected from a measurement process compared to the amount that was expected to be obtained. For this project, completeness refers to the proportion of valid, acceptable data generated using each method. The completeness objective for data collection during this demonstration is to take spectral readings continuously during the horizontal drilling process. Bit location readings at selected points corresponding to soil sample locations will be compared. Furthermore, the EMWD magnetometer readings will be compared to the position readings obtained by the driller. There is a physical limitation to the sensitivity and resulting range of spectral gamma measurements. These limitations relate to the Sodium Iodide (NaI) crystal size and maximum data collection rates. Expected range of 3 to 1000 pCi/g is the ideal system limitation.

9.1.5 Comparability

Analytical Data

Comparability is a qualitative parameter. Consistency in the acquisition, handling, and analysis of samples is necessary for comparing results. Data developed under this investigation will be collected and analyzed using standard EPA or nationally recognized analytical methods, and QC procedures to ensure comparability of results with other analyses performed in a similar manner. Data resulting from this sampling effort may be compared to other data sets. Quantitative values for PARCC parameters for the project are provided in Table 9-2.

<u>EMWD-GRS</u>

Comparability refers to the confidence with which one data set can be compared to another. The primary objective in implementing the EMWD-GRS technology will be to evaluate how well the EMWD system performed in determining position compared to data obtained by the driller. A secondary objective will be to determine how well the EMWD system performed in determining the presence of gamma-emitting radionuclides compared to analytical data derived from pervious site assessments. The expectation is to be consistent with offsite analysis methods.

9.2 Probability of False-Positive in EMWD-GRS Measurements

The probability of a false positive is the probability of detecting contaminated soil when contamination does not exist. The statistical nature of gamma measurements and electronic noise in any gamma measurement system does not provide a true zero reading. Given any sample period, there is a probability of measuring gamma relating to the energy levels of radiological material even without any laboratory-measurable quantities present. This problem requires setting the measurable threshold of radiological material below the minimum the system can measure accurately. This lower limit is an important parameter in preventing unwanted expense. The lower limit is a function of the sample period and drilling rate. The lower limit will be determined by the analysis of hundreds of background measurements previously taken around RFETS and from the *Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program, RFETS, May 1995.* Data from these sources will be entered into the calibration process.

10.0 SCHEDULE

Drilling and sample collection activities are scheduled to begin in early June 2000 and are anticipated to last six to eight weeks. The work will be conducted in two phases. Phase I will involve the horizontal drilling and sample collection of four boreholes beneath UBC 123 and of two boreholes beneath Building 886. Phase II will involve vertical profile soil sampling with a Geoprobe at each building. Actual Phase I sample locations may warrant changes in Phase II sample location and frequency, or vice-versa, at which time this SAP will be amended to accommodate such changes.

11.0 REFERENCES

DOE 1992a, *Final Phase I RFI/RI Work Plan for Operable Unit 9, Original Process Waste Lines, February*

DOE 1992b, *Historical Release Report for the Rocky Flats Plant, Rocky Flats Plant, Golden, CO, June*

DOE 1992c, *Final Phase I RFI/RI Work Plan for Operable Unit 13, 100 Area, October.*

DOE 1993, *Background Geochemical Characterization Report, September.*

DOE 1994, *Final Phase I RFI/RI Work Plan for Operable Unit 9, Technical Memorandum No. 1, RFP/ER-TMI-93-009.2, Volume IIA-Pipelines, November.*

DOE 1995a, *Data Summary No. 2 for Operable Unit No. 13, 100 Area, RF/ER-95-0090, Draft, June.*

DOE 1995b, *Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program, May.*

DOE 1995c, *Draft Data Summary 1, Operable Unit No. 14, Radioactive Sites, 95-DMR-ERM-0165, June*

DOE 1996, *Rocky Flats Cleanup Agreement, Final, July.*

DOE 1997, *RFETS, Integrated Monitoring Plan, June.*

EG&G, 1994, *Technical Memorandum No. 1, Investigation of Foundation Drains, Operable Unit 8, RFP/ERM-94-00011.*

EG&G, 1995a, *Geologic Characterization Report for the Rocky Flats Environmental Technology Site, Volume 1 of the Sitewide Geoscience Characterization Study, Final Report, April.*

EG&G, 1995b, *Hydrogeologic Characterization Report for the Rocky Flats Environmental Technology Site, Volume II of the Sitewide Geoscience Characterization Study, Final Report, April.*

EG&G, 1995c, *1994 Well Abandonment and Replacement Program Final Report, Rocky Flats Environmental Technology Site, March.*

EPA 1994, *Guidance for Data Quality Objectives Process, EPA QA/G-4, September.*

K-H, 1999, *Kaiser-Hill Team Quality Assurance Program, PADC-1996-00051, September.*

RMRS 1997a, *Proposed Action Memorandum for the Decommissioning of Building 123, May.*

RMRS 1997b, *Soil Sampling and Analysis Plan to Characterize Individual Hazardous Substance Sites (IHSSs) 121 and 148 at Building 123, RF/RMRS-97-023, Revision 1, May 14, 1998.*

REFERENCES (continued)

RMRS, 1997c, *1996 Annual Rocky Flats Cleanup Agreement (RFCA) Groundwater Monitoring Report for Rocky Flats Environmental Technology Site, RF/RMRS-97-087.UN, November.*

RMRS, 1998a, *Final Pre-Remedial Investigation of Individual Hazardous Substance Sites (IHSS) 121 and 148 at Building 123 Data Summary Report, Rev. 0, RF/RMRS-98-255.UN, September.*

RMRS, 1998b, *Final Close-Out Report Building 123 Decommissioning Project, RF/RMRS-98-253.UN, Rev.0, September.*

RMRS, 1999a, *RMRS Quality Assurance Program Description, RMRS-QAPD-001, Rev. 3, September.*

RMRS, 1999b, *In-Process Characterization Plan for the Building 886 Closure Project, RF/RMRS-99-349, Rev.0, October.*

RMRS, 1999c, *1998 Annual Rocky Flats Cleanup Agreement (RFCA) Groundwater Monitoring Report, RF/RMRS-99-433.UN, September.*

RMRS, 1999d, *Final Sampling and Analysis Plan for the D&D Groundwater Monitoring Report of Buildings 444, 771, and 886, RF/RMRS-99-313, Rev.0, July.*

Sandia National Laboratory, 1996, *Environmental Measurement-While-Drilling-Gamma Ray Spectrometer (EMWD-GRS) System Technology Demonstration Plan for Use at the Savannah River Site F-Area Retention Basin, SAND96-2019, August.*

Sandia National Laboratory, 1999, *Environmental Measurement-While-Drilling System and Horizontal Directional Drilling Technology Demonstration, Hanford Site, SAND99-1479, June.*

Trice, Conrad, 2000, interview with former Building 123 chemist, Rocky Flats Environmental Technology Site, Golden, CO, March.

Table 3-1 Constituents Detected above Minimum Detection Levels or Activities in Soil Samples Collected during Surface Soil Survey at IHSS 148

Constituents Detected Above Minimum Detection Levels or Activities	Maximum Concentration	Background Concentrations[a]	Tier II Soil Action Levels[b]
Chromium	95.6 mg/kg[c]	24.9 mg/kg[c]	4860 mg/kg[d]
Cobalt	28.7 mg/kg	24.8 mg/kg	123,000 mg/kg
Copper	43.4 mg/kg	27.3 mg/kg	81,800 mg/kg
Lead	165 mg kg	61.4 mg/kg	1000 mg/kg
Nickel	52.4 mg/kg	26.8 mg/kg	40,900 mg/kg
Strontium	94.7 mg/kg	90.1 mg/kg	>1,000,000 mg/kg
Zinc	1,220 mg/kg	86.6 mg/kg	>1,000,000 mg/kg
Americium-241	0.197 $\pm$ 0.032	0.0227 pCi/g	38 pCi/g
Plutonium-239/240	0.169 $\pm$ 0.04 pCi/g	0.066 pCi/g	252 pCi/g
Uranium-233/234	2.04 $\pm$ 0.396 pCi/g	2.253 pCi/g	307 pCi/g
Uranium-238	2.14 $\pm$ 0.309 pCi/g	2.00 pCi/g	103 pCi/g

[a] Source: DOE 1995b, *Geochemical Characterization of Background Surface Soils: Background Soils Characterization Program,* May.
[b] Source: DOE 1996, *Final Rocky Flats Cleanup Agreement*, July. Metal analyte action levels are based on office worker exposure to soil; radionuclide action levels are based on annual dose limits.
[c] Tier II soil action level indicates total chromium (chromium III + chromium VI).
[d] Result indicates chromium VI only. Action level for chromium III is >1,000,000 mg/kg.

Table 6-1 Building 123 HDD Sampling Locations and Specifications

Drilling Method/ Borehole	Sample I.D.	Location/Area of Interest	No./Length of Horizontal Interval(s) to be Collected (ft)	Estimated Depth (ft bgs)	Comments
HDD Line 1	HDD-1-01	Room 156 Sump	(1) 2-3 Feet	6	Immediately beneath & east of OPWL P-1 near sump
	HDD-1-02	Between Sumps of Rooms 156&157	"	6	Immediately beneath & east of OPWL P-1 between sumps
	HDD-1-03	Room 157 Sump	"	6	Immediately beneath & east of OPWL P-1 near sump
	HDD-1-04	Room 158 Sump	"	6	"
	HDD-1-05	Between Rooms 158&MH-1	"	6	Immediately beneath & east of OPWL P-1
	HDD-1-06	Btwn Rm 158&MH-1	"	6	"
	HDD-1-07	MH-1	"	6	Intersection of MH-1 and OPWL P-1
HDD Line 2	HDD-2-01	Just inside northern footing of Room 107A Area	(1) 2-3 Feet	6	Along HDD Line 2 Borehole, spaced 15' apart
	HDD-2-02	15' South of last Sample	"	6	Beneath hallway, north of Rm 122
	HDD-2-03	15' South of last Sample	"	6	Beneath Room 122, Routine
	HDD-2-04	Room 123	"	6	South of P-1/P-2 Intersection, Rm 123
	HDD-2-05	15' South of last Sample	"	6	Beneath N area Room 124, Routine
	HDD-2-06	WPS P-1	"	6	Beneath WPS P-1, N area Room 125
	HDD-2-07	15' South of last Sample	"	6	Beneath Room 125 area, Routine
	HDD-2-08	15' South of last Sample	"	6	Beneath N area Room 126, Routine
	HDD-2-09	15' South of last Sample	"	6	Beneath Room 126 area, Routine
	HDD-2-10	15' South of last Sample	"	6	Beneath Room 127 area, Routine
	HDD-2-11	15' South of last Sample	"	6	Beneath Room 128 area, Routine
	HDD-2-12	15' South of last Sample	"	6	Beneath hallway, Room 143/140 area
	HDD-2-13	15' South of last Sample	"	6	Southern portion of Room 144
HDD Line 3	HDD-3-01	~3' west of MH-1	(1) 2-3 Feet	6	Within PAC 100-603 (upgradient)
	HDD-3-02	East of MH-1	"	6	Immediately east of MH-1 (downgradient)
	HDD-3-03	15' South of last Sample	"	6	Along P-1(s), Routine
	HDD-3-04	15' South of last Sample	"	6	Along P-1(s), Routine
	HDD-3-05	15' South of last Sample	"	6	Along P-1(s), Routine
	HDD-3-06	Just west of MH-2	"	6	Immediately west of MH-2 (upgradient)
	HDD-3-07	15' South of last Sample	"	6	Immediately east of MH-2 (downgradient) and near PAC 100-611
	HDD-3-08	15' South of last Sample	"	6	Beneath Room 165, Routine
	HDD-3-09	15' South of last Sample	"	6	Beneath Room 165, Routine
	HDD-3-10	15' South of last Sample	"	6	Just west (upgradient) of MH-3
	HDD-3-11	MH-3 & P-3	"	6	Just east (downgradient) of MH-3
HDD Line 4	HDD-4-01	NW corner Rm 111	(1) 2-3 Feet	6	Just beneath & along P-2
	HDD-4-02	15' South of last Sample	"	6	NE corner Rm 111
	HDD-4-03	15' South of last Sample	"	6	NE corner Rm 112
	HDD-4-04	15' South of last Sample	"	6	Room 113 Area
	HDD-4-05	15' South of last Sample	"	6	Room 119A Area
	HDD-4-06	15' South of last Sample	"	6	Room 119/122 Area

Table 6-2 Building 123 Geoprobe Sampling Locations and Specifications

Geoprobe Locations	Geoprobe Sample I.D.	Collocated HDD Line Sample I.D.	Location/Area of Interest	No./Length of Vertical Interval(s) to be Collected (ft)	Estimated Depths (ft below foundation)	Comments
Geoprobe Sample Locations Along HDD Lines						
HDD Line 1	GP-1-01	HDD-1-01	Rm 156 Sump	(1) 2 Feet	3'2" - 5'2"	Sump bottom is 4'2" bgs
	GP-1-03	HDD-1-03	Rm 157 Sump	(1) 2 Feet	4'0" - 6'0"	Sump bottom is 5'0" bgs
	GP-1-04	HDD-1-04	Rm 158 Sump	(1) 2 Feet	4'3" - 6'3"	Sump bottom is 5'3" bgs
	GP-1-07	HDD-1-07	MH-1	(1) 2 Feet	5' to 7'	Bound HDD-1-07 by one foot above & below
HDD Line 2	GP-2-01	HDD-2-01	Northern footing Room 107	(1) 2 Feet	5' to 7'	Bound HDD-2-01 by one foot above & below
	GP-2-04	HDD-2-04	Room 123 Area	(1) 2 Feet	5' to 7'	Bound HDD-2-04 by one foot above & below
	GP-2-06	HDD-2-06	WPS-1/OPWL P-2	(2) 2 Feet	0' to 2' & 5' to 7'	Bound HDD-2-06 by one foot above & below
	GP-2-08	HDD-2-08	Room 126C Area	(1) 2 Feet	5' to 7'	Bound HDD-2-08 by one foot above & below
	GP-2-10	HDD-2-10	Room 127 Area	(1) 2 Feet	5' to 7'	Bound HDD-2-10 by one foot above & below
	GP-2-13	HDD-2-13	S. edge of Rm 144/146	(1) 2 Feet	5' to 7'	Bound HDD-2-13 by one foot above & below
HDD Line 3	GP-3-01	HDD-3-01	~3 Ft west of MH-1	(1) 2 Feet	5' to 7'	Bound HDD-3-01 by one foot above & below
	GP-3-04	HDD-3-04	Along P-1	(1) 2 Feet	5' to 7'	Bound HDD-3-04 by one foot above & below
	GP-3-07	HDD-3-07	East of MH-2	(1) 2 Feet	5' to 7'	Bound HDD-3-07 by one foot above & below
	GP-3-09	HDD-3-09	Along P-1	(1) 2 Feet	5' to 7'	Bound HDD-3-09 by one foot above & below
	GP-3-11	HDD-3-11	~5 feet east of MH-3	(1) 2 Feet	5' to 7'	Bound HDD-3-11 by one foot above & below
HDD Line 4	GP-4-01	HDD-4-01	NW corner of Rm 111	(1) 2 Feet	5' to 7'	Bound HDD-4-1 by one foot above & below
	GP-4-04	HDD-4-04	Room 119 Area	(1) 2 Feet	5' to 7'	Bound HDD-4-04 by one foot above & below
	GP-4-06	HDD-4-06	NW corner of RM 122	(1) 2 Feet	5' to 7'	Bound HDD-4-06 by one foot above & below

48

Table 6-2 Building 123 Geoprobe Sampling Locations and Specifications (continued)

Geoprobe Locations	Geoprobe Sample I.D.	Collocated HDD Line Sample I.D.	Location/Area of Interest	No./Length of Vertical Interval(s) to be Collected (ft)	Estimated Depths (ft below finished surface)	Comments
Geoprobe Sample Locations at Other Areas of Interest						
Source Pit 1	SP-1	N/A	Source Storage Pits Room 109	(1) 2 Feet	0" to 24"	Bound bottom of pit elevation by one foot above & below
Source Pit 2	SP-2	N/A	Source Storage Pits Room 109	(1) 2 Feet	4" to 28"	Bound bottom of pit elevation (16") by one foot above & below
Source Pit 3	SP-3	N/A	Source Storage Pits Room 109	(1) 2 Feet	4" to 28"	Bound bottom of pit elevation (16") by one foot above & below
Source Pit 4	SP-4	N/A	Source Storage Pits Room 109B	(1) 2 Feet	4" to 28"	Bound bottom of pit elevation (16") by one foot above & below
Waste Pumping Station-1	WPS-1	N/A	Immediately east (downgradient) of WPS-1	(1) 2 Feet	0" to 24"	Bound bottom of concrete pit elevation (12") by one foot above & below
Waste Pumping Station-2	WPS-2	N/A	Immediately east (downgradient) of WPS-2	(1) 2 Feet	0" to 24"	Above ground WPS, no pit. Collect first 24" beneath slab
Waste Pumping Station-3	WPS-3	N/A	Immediately east (downgradient) of WPS-3	(1) 2 Feet	0" to 24"	Above ground WPS, no pit. Collect first 24" beneath slab
Waste Pumping Station-4	WPS-4	N/A	Immediately east (downgradient) of WPS-4	(1) 2 Feet	0" to 24"	Above ground WPS, no pit. Collect first 24" beneath slab
Waste Pumping Station-5	WPS-5	N/A	Immediately east (downgradient) of WPS-5	(1) 2 Feet	1' 3" to 3'3"	Bound bottom of concrete pit elevation (2'3") by one foot above & below
Waste Pumping Station-6	WPS-6	N/A	Immediately east (downgradient) of WPS-6	(1) 2 Feet	1' 3" to 3'3"	Bound bottom of concrete pit elevation (2'3") by one foot above & below
Room 105 Lab	Lab-1	N/A	Soil adjacent to drains of Room 105 Lab	(1) 2 Feet	0" to 24"	Collect first 24" of soil beneath slab near drain
Room 105 Lab	Lab-2	N/A	Soil adjacent to drains of Room 105 Lab	(1) 2 Feet	0" to 24"	Collect first 24" of soil beneath slab in scabbled region

Table 6-3 Building 886 HDD Sampling Locations and Specifications

Building 886 HDD Sample Intervals					
Drilling Method/ Borehole	**Sample I.D.**	**Location/Area of Interest**	**No./Length of Horizontal Interval(s) to be Collected (ft)**	**Estimated Depth (ft)**	**Comments**
HDD Line 5	HDD-5-01	Room 108 (Hallway)	(1) 2-3 Feet	4-4.5	Just east of Rm 103 Pit (Downgradient)
	HDD-5-02	Room 103 Pit	(1) 2-3 Feet	4-4.5	East/Northeast portion of Room 103 Pit
	HDD-5-03	Room 103 Pit	(1) 2-3 Feet	4-4.5	North Central portion of Room 103 Pit
	HDD-5-04	Room 103 Pit	(1) 2-3 Feet	4-4.5	Northwestern portion of Room 103 Pit
HDD Line 6	HDD-6-01	Room 101- East	(1) 2-3 Feet	3-3.5	Immediately inside the eastern footing of Room 101 in the NE corner of the room
	HDD-6-02	Room 101- Central	(1) 2-3 Feet	3-3.5	Approximately 10 ft west of HDD-6-01
	HDD-6-03	Room 101- Central	(1) 2-3 Feet	3-3.5	Approximately 10 ft west of HDD-6-02, just north of "doghouse"
	HDD-6-04	Room 101- West	(1) 2-3 Feet	3-3.5	Immediately inside the western footing of Rm 101 in the NW corner of the room
Note: Depths of HDD samples beneath Room 101 may be approximately 6 feet bgs if drilling through foundation to access shallower depths proves unsuccessful.					

Table 6-4 Building 886 Geoprobe Sampling Locations and Specifications

Building 886 Geoprobe Sample Intervals						
Geoprobe Locations Along HDD Lines	**Geoprobe Sample I.D.**	**Collocated HDD Line Sample I.D.**	**Location/Area of Interest**	**No./Length of Vertical Interval(s) to be Collected (ft)**	**Estimated Depths (ft below finished surface)**	**Comments**
HDD Line 5 B886 Room 103 Pit	GP-5-02	n/a	NE portion Room 103 Pit	(2) 2 feet long	0-2/ 3-5	Collect 1st soil interval; Bound HDD soil sample by one foot above & below
	GP-5-03	n/a	N Central Room 103 Pit	(2) 2 feet long	0-2/ 3-5	Collect 1st soil interval; Bound HDD soil sample by one foot above & below
	GP-5-05	n/a	Center of Room 103 Pit	(2) 2 feet long	0-2/2-4	Continuously sample 1st 4 feet beneath slab (2 separate intervals)
	GP-5-06	n/a	South Central Room 103 Pit	(2) 2 feet long	0-2/2-4	Continuously sample 1st 4 feet beneath slab (2 separate intervals)
HDD Line 6 B886 Room 101	GP-6-01	HDD-5-01	NE corner of Room 101	(2) 2 feet long	0-2/ 2.5-4.5	Collect 1st soil interval; Bound HDD soil sample by one foot above & below
	GP-6-04	HDD-5-04	NW corner of Room 101	(2) 2 feet long	0-2/ 2.5-4.5	Collect 1st soil interval; Bound HDD soil sample by one foot above & below
	GP-6-05	n/a	SE corner of Room 101	(2) 2 feet long	0-2/2-4	Continuously sample 1st 4 feet beneath slab (2 separate intervals)
	GP-6-06	n/a	SW corner of Room 101	(2) 2 feet long	0-2/2-4	Continuously sample 1st 4 feet beneath slab (2 separate intervals)

Table 6-5 Analytical Requirements for Soil Samples

Analysis	Matrix	Estimated No. of Samples		EPA Method and/or ASD Line Item Code	Container[a]	Preservation	Holding Time
		HDD	Geoprobe				
Sample Analysis Suite for All HDD and Geoprobe Soil Samples Collected at UBC 123 and Building 886							
Isotopics ($U^{233/234}$, U^{235}, U^{238}, Am^{241}, $Pu^{239/240}$)	Soil	45 (+3 Dups)	~45 to 60 (+3 to 4 Dups[c])	ASD Line Item Code RC01B003	1 (one) 250 ml glass jar	None	180 days
Target Compound List (TCL) Volatiles	Soil	45 (+3 Dups)	~45 to 60 (+3 to 4 Dups[c])	SW-846 Method 8260A/ ASD SS01B002 or SS01B003	2 (two) 125 ml wide-mouth glass teflon-lined jars	Cool, 4° C; Zero-head space	7 days
Target Compound List (TCL) Semi-Volatiles	Soil	45 (+3 Dups)	~45 to 60 (+3 to 4 Dups[c])	SW-846 Method 8270B/ ASD SS02B002	1 (one) 250 ml wide-mouth amber glass teflon-lined jar[b]	Cool, 4° C	7 days until extraction, 40 days after extraction
Target Analyte List (TAL) Metals (total)	Soil	45 (+3 Dups)	~45 to 60 (+3 to 4 Dups[c])	SW-846 Method 6010A; Method 7471A (Hg-Solid)/ ASD SS05C039	1 (one) 250 ml wide-mouth glass teflon-lined jar[b]	Cool, 4° C	180 days
PH	Solid Waste	45 (+3 Dups)	~45 to 60 (+3 to 4 Dups[c])	ASD SS08C026	1 (one) 250 ml wide-mouth glass teflon-lined jar[b]	Cool, 4° C	180 days
Additional, Site-Specific Analyses							
$Cesium^{137}$ Building 123 Rm. 109	Soil	0	(4) Sample IDs SP-1 through SP-4 only	ASD RC10A017 or RC10A019- by Gamma Spec	1 (one) 500 g wide-mouth glass teflon-lined jar (A017); Any other container (A019)	N/A	N/A

[a] Sample container sizes and volumes may differ from those stated as specified by ASD.
[b] SVOC, Metals, and pH analysis samples may be combined into the same sample container if analyses are performed by the same laboratory.
[c] Duplicate samples will be collected at a frequency of 1 for every 20 real samples, or portion thereof.

51

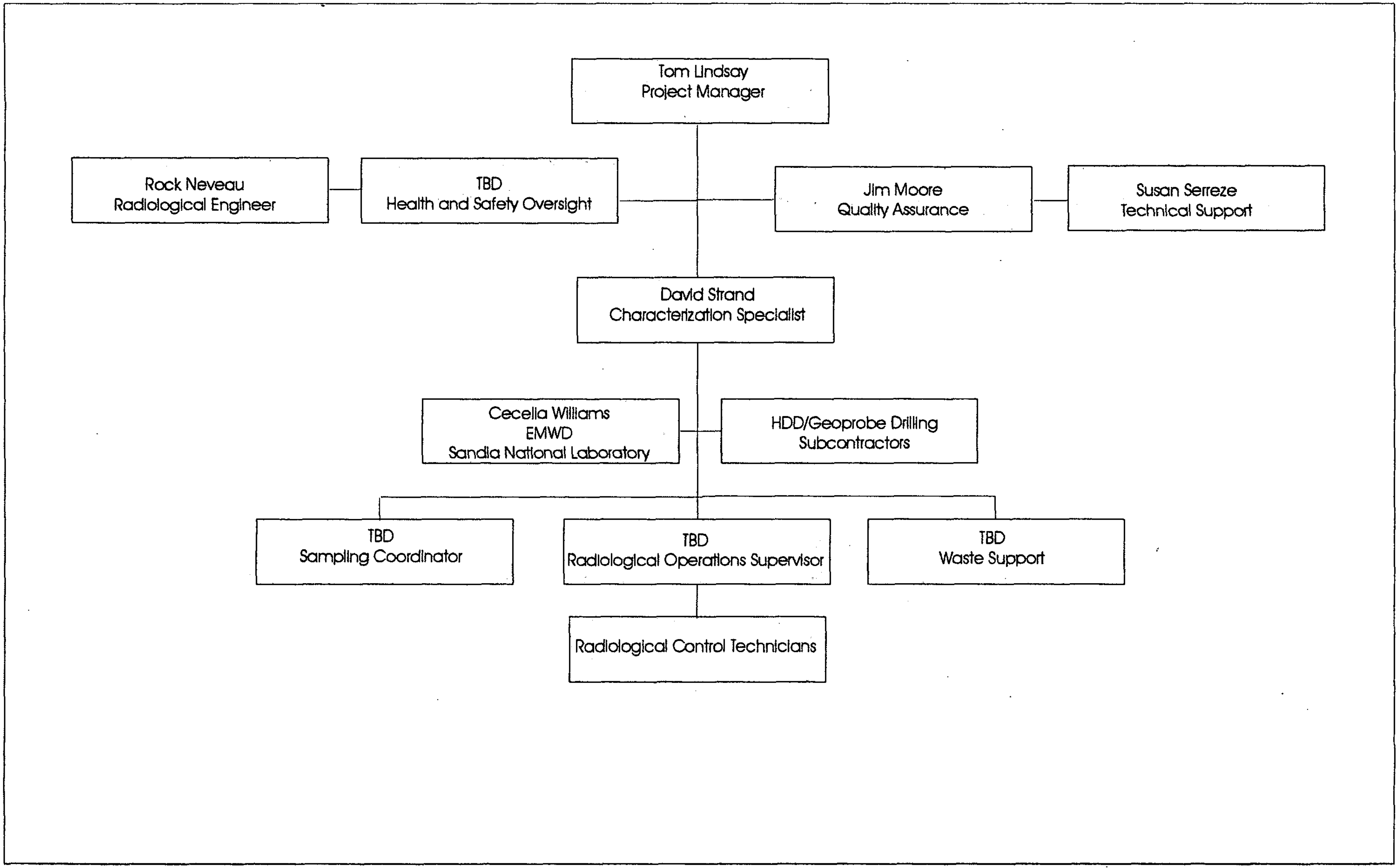
Table 9-1 QA/QC Sample Type, Frequency, and Quantity

Sample Type	Frequency	Comments	Quantity (estimated)
Duplicate	One duplicate for each twenty real samples		4 HDD 4 Geoprobe
Rinse Blank	One rinse blank for each twenty real samples	To be performed with reusable sampling equipment following decontamination procedures	4 HDD 4 Geoprobe
Trip Blank	One trip blank per shipping container as needed to comply with sample holding times	To accompany VOC analysis shipments only	1-2 per week

Table 9-2 PARCC Parameter Summary

PARCC	Radionuclides	Non-Radionuclides
Precision	Duplicate Error Ratio ≤ 1.96	RPD ≤ 30% for Soil RPD ≤ 40% for Water
Accuracy	Detection Limits per method and ASD Laboratory SOW	Comparison of Laboratory Control Sample Results with Real Sample Results
Representativeness	Based on SOPs and SAP	Based on SOPs and SAP
Comparability	Based on SOPs and SAP	Based on SOPs and SAP
Completeness	90% Useable	90% Useable

Figure 8-1
Organization Chart
for Characterization of UBC at Buildings 123 and 886
Implementing HDD/EMWD Process



APPENDIX A

EMWD-GRS Spectral Gamma Calibration Procedure
(provided by Sandia National Laboratories)

55

EMWD Spectral Gamma Calibration and Field Measurement

Introduction
There are two main elements for converting spectral gamma energy readings into a indication of soil contamination levels. First is the linear correlation of gamma energy Vs channel location. In general this correlation can be determined in the lab using known source material emitting gamma particles at differing energy levels. Second is the calibration of gamma flux density Vs contamination levels. This second process is not directly determined by laboratory standards. In fact this second step is under investigation at many DOE waste sites.

In this report a calibration process is looked at for the spectral gamma NaI detector used in the environmental measurement while drilling system (EMWD). A quick look at linear channel calibration is given, using actual EMAD laboratory data. To better understand the unfolding process for calculating radionuclides, a short explanation for unfolding naturally occurring radionuclides for uranium exploration is given. This process is also used to gage the performance of newly developed spectral systems for environmental work. Following the unfolding process for natural radiation will be a look at actual spectral logging data from a waste site and an unfolding method for cesium and cobalt.

The final goal of this work is to justify and document reasoning for taking a simpler approach concentrating on cesium detection.

Gamma Energy Vs Channel Location
This function very closely matches a straight line with a zero intercept, measured gamma energy = a * (Channel Number) + b. The NaI crystal sensor is exposed to differing radionuclide, emitting gamma particles of differing energy levels. Exposure is continued until peaks appear in the spectrum at count levels assuring accurate peak channel measurement, normally > 100 counts or X10 background. Below are the laboratory measured values for the given sources.

Table 1: Linear Calibration Results

Source Element	Peak Energy (MeV)	Peak Channel Number	% Difference From Calc.
Cs 137	0.662	92	1.1
Co 60	1.173, 1.332	163, 186	0.7, 0
Mn 54	0.835	115	1.7
Na 22	0.511, 1.275	74,178	2.9, 0

The resulting linear regression for energy Vs channel number is: Y MeV = 7.18 $X10^{-3}$ MeV * (Channel Number) - 4.90XIO^{-3} MeV @ room temperature. Working backwards using the given channel number and the known energy gamma the percent deference was calculated. The correlation coefficient of Table I values is 0.9996. The linear response of a NaI detector is very good. However, a number of factors can cause the slope 'a' to change while drilling, primarily temperature, high voltage drift, and photon-multiplier tube aging. Controlling these parameters is critical to proper measurement.

Flux Density Vs Contamination Levels

Gamma counts rate is a relative measure of gamma flux, dependent on many factors as detector size, housings, etc. This flux is proportional to the amount of radioactive material in the soil. Thus, the measured flux is converted to pCi/g by calibration coefficients derived from calibration models. These models have known amounts of source material distributed in a large enough volume to appear infinitely large to traveling gamma rays, about a two to four foot radius about the sensor.

However, soil conditions infinitely vary for moisture content and physical make up. Moisture and soil types influence the measured gamma flux Limitations in calibration for flux density Vs contamination levels in soil result in an assumption that all soil conditions are consistent with the calibration models.

The most commonly used calibration models are maintained for DOE's Grand Junction Projects Office in Grand Junction Co. by contract with Rust Geotech Inc[i]. These models were built to calibrate instrumentation used for uranium exploration. As such these models contain three naturally occurring elements, K-40, Ra-226, and Th-232, (KUT). Because these models are well characterized and documented they are used to set a baseline accuracy for all subterranean gamma instrumentation. Stromswold (1981) uses gamma count windows centered about energy peaks of the three naturals which unfold from highest energy to lowest. Table 2 shows his suggested windows.

Table 2 Spectral Energy Windows for Unfolding KUT

Element	Unique Gamma Ray (MeV)	Energy Window (MeV)
Potassium (K40)	1.46	1.320-1.575
Uranium (Ra-226)	1.76 & 2.20	1.650-2.390
Thorium (Th-232)	2.61	2.475-2.765

In working with subterranean gamma there is a problem of higher energy gamma rays being counted in lower channels, down scattering. By choosing the thorium. window about the 2.6 1 MeV gamma, thorium can be solved for because potassium and uranium don't have any gamma rays higher than 2.39MeV. Once thorium is known then the solution for uranium can be found because potassium is below the 1.65MeV window used for uranium. This process is called unfolding. The Grand Junction B models are well suited for this unfolding process. The B model concentrations listed in Table 3 below.

Table 3. Grand Junction B-Model Concentrations

Model	Concentration Th (PCi/g)	Concentration Ra (PCi/g)	Concentration K (PCi/g)
BT Upper	58.78 ± 1.53	10.46 ± 0.51	10.13 ± 1.34
BU Upper	0.65 ± 0.06	194.59 ± 5.94	10.63 ± 1.00
BK Lower	0.10 ± 0.02	1.03 ± 1.67	54.00 ± 1.67

By placing the spectrometer into each of the three models, subtracting electrical noise, and counting gamma for each of the three windows in Table 2, a rate matrix R is produced. Matrix R is guaranteed to be nonsingular because of the window selection process assures an upper triangular form. Using the concentrations of Table 3 a set of coefficients relating window count rates to concentrations (pCi/g) can be solved for using Eq1. An important note on counting periods; The statistical nature of gamma counting requires long enough counting periods to gain a meaning full count rate. The standard deviation of the gamma count is equal to its square root, i.e. 100counts has a 10count sdv.

$$A \quad = \quad CR^{-1} \text{ Eq1}$$

A is a 3X3 Matrix of Calibration Coefficients
R is a 3X3 Matrix of Count Rate reading for each of the three windows
C is a 3X3 Matrix of Known model concentrations from Table 3

Once A is known then the system is tested against a forth model (BM) which is a mix of all three elements. A properly calibrated spectrometer then solves for concentration levels for KUT using equation Eq2.

$$C \quad = \quad AR \quad \text{Eq2}$$

Equation 2 is used to convert gamma flux rates to density measurements in pCi/g as the system is drilling or logging. There are a number of additional considerations to the process which should be addressed. First, the linear calibration relating gamma energy peaks to channel numbers in the spectrum is used for setting the KUT windows of Table 2. Anything which alters this calibration effects the calculated concentration levels. The measure of the gamma rate is dependent on concentration levels but also the MCA conversion rate. Low power MCAs normally employ slow conversion methods increasing dead time (DT). Where DT and R are both in units of seconds, Eq3 below is used compensate for a slow MCA.

$$R' = R^{*} \text{ 1sec} / (\text{1sec} - DT) \text{ Eq3.}$$

DT is a function of MCA total counts and conversion time
R' is a new MCA compensated rate matrix

In the general solution of converting gamma count rates to KUT soil concentrations, a basic assumption was made; Only naturally occurring gamma sources are found in the soil. The man-made rad waste creates a new set of gamma emmitters in contaminated soils.

In the case of Cesium (Cs-137), its' gamma ray is at 0.66MeV. Using this unfolding process Cesium would be unfolded after potassium. Too follow this logic, every radioactive element distributed within the soil must be accounted for in the unfolding process. The dominate waste radionuclides generally found in the soils at Hanford and Savannah River are Cesium- 137, Europium- 154, Europium-1 52, and Cobalt-60. Ina Westinghouse Savannah River 1994 report on H-Area retention basin list maximum concentrations as shown in Table 4. Table 4 is by no means a complete list of man-made waste, rad or otherwise.

Table 4. Example of found Radionuclides at a Waste Site

Radionuclides	Max. Concentration, pCi/g
Cesium- 13 7	33000
Europium-152	47
Europium-1 54	33
Cobalt-60	1.8

Figure 1 is log data taken with a HPGe detector used at Hanford, (C.J. Koizumi, 1993). There are two important attributes demonstrated by this data. First, the total count is a good indicator of waste radionuclides in the soil. Second, cesium waste maybe independent of other radionuclides.

A complete gamma spectrum is shown in Figure 2. This spectrum was taken at 16.8m depth in the log run shown in Figure 1. Here the spectrum is scaled out to 2.8MeV. By scaling out so high the thorium peak at 2.61 MeV can be monitored for changing backgrounds. The measured concentrations for this spectrum at as follows: 3 pCi/g of Co-60, 29 pCi/g of Eu-154 and 8 pCi/g of K-40. The vast majority of spectral activity is below the K-40 peak at 1.46MeV.

Looking again at Figure 2, the down scattering of higher energy gamma into the 0.66MeV energy channel is a concern. Because of the low energy Cs-137 gamma virtually all background and other man-made rad waste interferes with the cesium measurement.

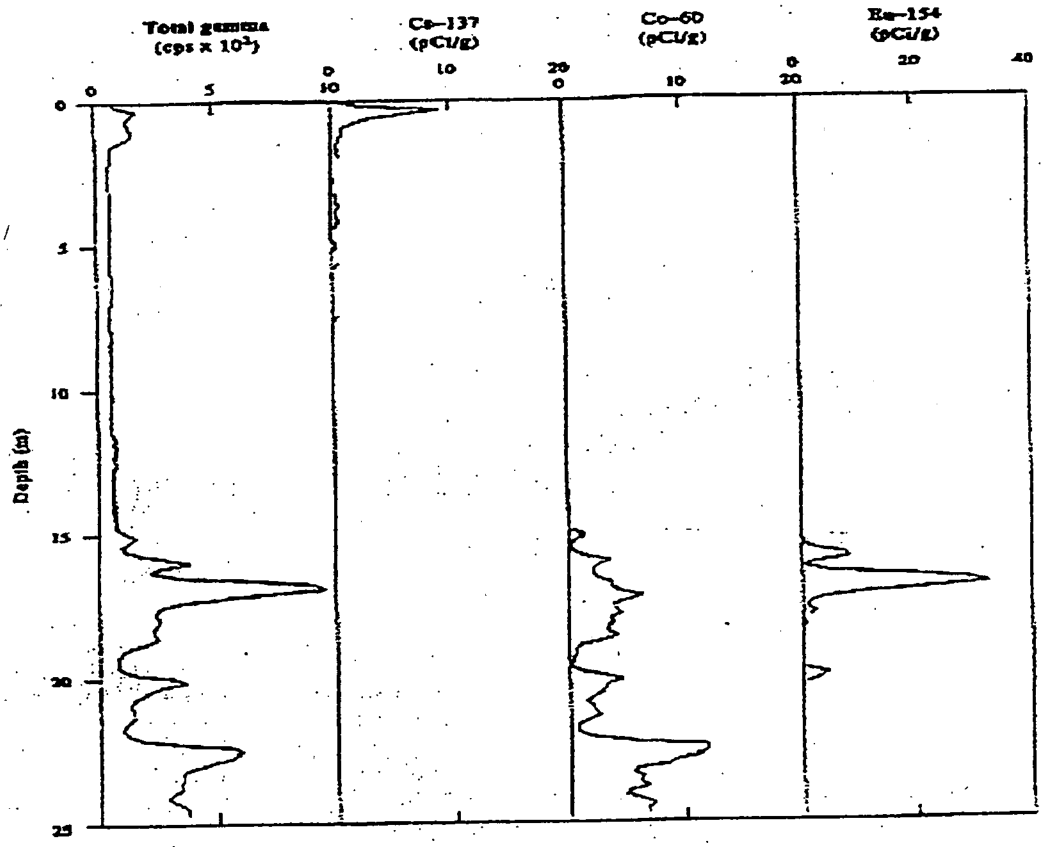


Figure 1. Spectral log near Hanford waste tank, (C.J. Koizumi, 1993)

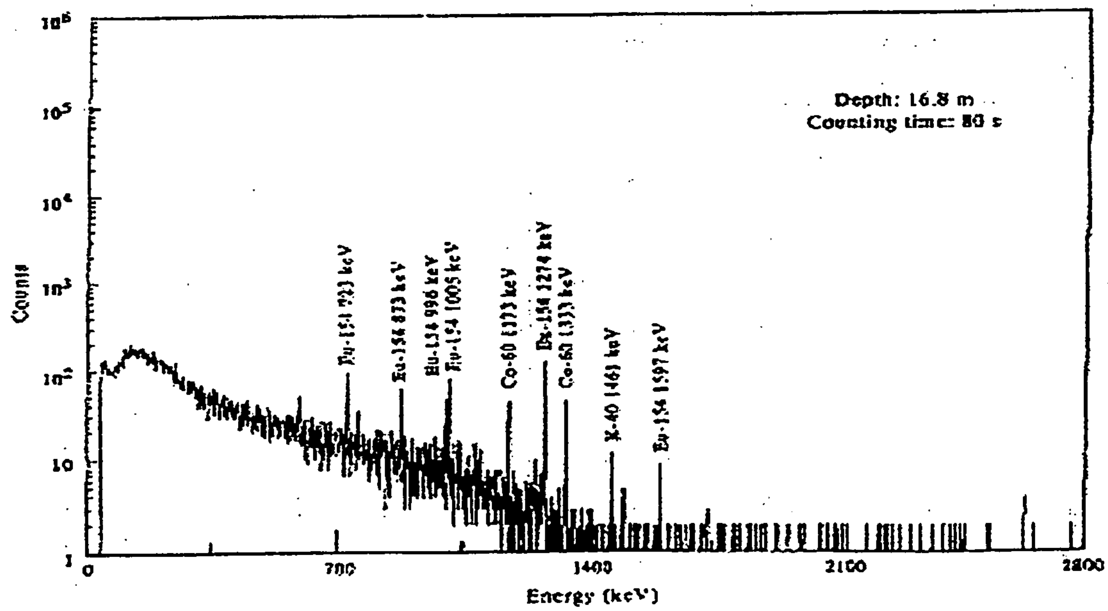


Figure 2. An example of a complete gamma spectrum taken for the log in Figure 1. (C.J. Koizumi, 1993)

60

Unfolding Co and Cs From Background, An Example

Unfolding the three naturals along with cesium and cobalt (Randall and Stromswold, 1995) used windows 1.105 to 1.420MeV for cobalt and 0.590 to 0.715MeV for cesium. Lumping the background Th and U counts as a single constant term, the Cs and Co unfolding formulas are shown below.

$$C_{co} = aR_{co} - bR_{K} \quad cR_{CS} \quad - \quad BKG_{C0} \qquad \text{Eq4.}$$

$$C_{cs} = dR_{cs} - ER^{2}_{cs} \quad - \quad fR_{co} \quad - \quad BKG \qquad \text{Eq5.}$$

Terms "a" - "f" are unique coefficients.

BKG is the constant background subtraction of each element.
In all cases BKGcs, > BKGco.

Both equations 4 and 5 use the K40 rates directly. This is done because the cobalt upper gamma is very near that of potassium. The NaI detector resolution will overlap gamma counts. In Eq5 has a cobalt count rate term for calculation of cesium. Often cesium and cobalt are found together and the down scattering of the higher energy cobalt is a significant. Eq5 incorporates a squared term for pile up correction at very high count rates.

Suggested Approaches For EMWD

The EMWD MCA is a 256 channel multi-channel analyzer. The NaI crystal is (at present) a four by one inch cylinder. Complete spectrums are transmitted to the surface every 30 seconds. Spectrums are not being taken while data is being transmitted. The actual sample period is ~20 seconds. Spectrums can be summed at the surface to longer sample periods.

The main focus of the EMWD system is to detect and measure cesium contamination levels while drilling. There are no cesium waste models for calibration of spectral gamma logging systems. Even if such a model existed there are too many types of mixed radionuclides at each DOE site for any NaI system to accurately unfold. Two methods are suggested for calibrating a system to unfold Cs-13 7 from natural background spectrums. In both cases, total gamma counts will be used to detect increased levels of man-made waste. The total count might also help detect when count rates are increased by manmade waste other than Cs-13 7 by the simple relationship in Eq6.

$$TC - aR_{cs} - bR_{K} - BKG_{TC} = 0 \qquad \text{Eq6}$$

TC = total counts
BKG_{TC} taken from reading is a clean area
a & b coefficients derived from field testing.

Calibration Method I

This method would treat the spectrum readings in the same fashion as calibrating any spectral gamma logging system as addressed earlier in this report.

Set the linear range to 2.8OMeV, full scale. Choose windows for all three naturals plus Cs-137. Eq1 is now composed of 4X4 matrixes. B-models can be used where the model concentration of Cs-137 is assumed zero. To solve for matrix A a forth model of known concentration of Cs-137 must be used.

This Cs-137 model may actually be a characterized well as logged in Figure 1 at a waste site. This approach is heavily dependent on the quality of the Cs-137 model. The matrix inversion simultaneous solution of linear equations produces a least squares fit to given data. The solution maybe sensitive to slight changes in concentration levels, non-robust. This problem is compounded by the lack of a properly configured mixed model to help test the solution.

Calibration Method 2

The energy range will be low, upper end limited at 1.6MeV. This is done to utilize system sensitivity about the range of interest, see Figure 2. Gamma rays above this threshold are counted as a total and stored in channel 255. By monitoring this channel normal thorium and uranium background levels can be monitored. These background levels will be characterized at the site by drilling a short bore outside of the contaminated area. Along with channel 255, the potassium and cesium windows will also be characterized for background down scattering. Using the B-model, the cesium window can be characterized for potassium down scattering.

$$C_{cs} = aR_{cs} - bR_K - BKG_{cs} \quad \text{Eq7}$$

Several cesium dominated wells of differing levels will be required to curve fit system response to cesium. If background reading remain constant and Cs-137 dominates all other types of man-made waste then the linear relationship should be well bounded.

Conclusion

The EMWD spectrometer is capable of linear calibration of gamma energy peaks at room temperature. The logging industry in cooperation with DOE has developed spectral gamma calibration methods and facilities. These method and facilities are not sufficient to fully calibrate spectral gamma systems for subterranean measurement of man-made mixed waste.

Actual logging data taken of rad waste by a HPGe system points to the complexity of the problem. For the EMWD system using a NaI detector there is no recognized solution for calibration or unfolding spectrums in man-made rad waste sites with unknown radionuclide.

Two methods were looked for calibration and unfolding. One method expands the accepted method used for spectral gamma logging tool calibration used in uranium exploration wells. The second method assumes a fixed background and attempts to equate a linear relationship between gamma count rates in cesium directly. Both methods, and some combination of approaches needs to be tested before release for site characterization.

'R- Leino, D.C. George, B.N. Key, L. Knight, and W.D. Steele, June 1994, Third Edition, Field Calibration Facilities for Environmental Measurement of Radium, Thorium, and Potassium, technical Measurements Center Grand Junction Projects Office

APPENDIX B

Drilling Equipment Description/Specifications for the HDD/EMWD Implementation at UBC 123 and Building 886

63

EMWD/HDD TECHNOLOGY DESCRIPTION

The components of a horizontal drilling rig are similar to those of a conventional drilling rig except that a horizontal drilling rig is equipped with an inclined ramp as opposed to a vertical mast. HDD pilot hole directional control is achieved by applying thrust to a non-rotating, somewhat flexible drill string with an asymmetrical leading edge. The asymmetry of the leading edge creates a steering bias while the non-rotating drill string allows the steering bias to be held in a specific position while pushing. If a change in direction is required, the drill string is rolled so that the direction of bias is the same as the desired change in direction. The direction of bias is referred to as the tool face. Straight progress may be achieved by drilling with a series of offsetting tool face positions. The drill string may also be continually rotated where directional change is not required (Sandia, 1999). Coupled with the EMWD technology, this system shows to be a promising method of accessing specific and/or otherwise hard to reach areas of interest for UBC site soil characterization.

Technology Capabilities
The EMWD-Gamma Ray Spectrometer (GRS) system is compatible with a directional drilling technique that uses minimal drilling fluids and generates little or no secondary waste. The down-hole sensors are located behind the drill bit and are linked by a high-speed data transmission system to a computer at the surface. Sandia-developed, Windows™-based software is used for data display and storage. As drilling is conducted, data are collected on the nature and extent of gamma-emitting contamination. Data are instantly accessible for on-the-spot decisions about drilling and sampling strategies. The system also has the capability of being able to "steer" the drill bit into or out of hazardous zones.

The EMWD-GRS System- Basic System Operations
The system is comprised of four parts: a computer, a stationary magnetic pickup coil and receiver, a battery pack and magnetic coil, and a down-hole electronics package. The electronics package, complete with a GRS, multichannel analyzer, and coaxial coil, is located inside the drill rod next to the drill bit. The coil provides both direct current (DC) power and alternating current (AC) signal paths between the surface and the down-hole electronics package. The receiver converts the FM signal into a serial bit stream. A computer equipped with a telemetry serial card receives the data and displays down-hole measurements in real time. Real time data is displayed on an eight differential/single analog multiplexer and any number of digital channels. Sampling speed from analog channels can reach 100 kHz. Three digital channels are used on this system. Readings are taken at a rate of 20 per second. The telemetry system can support many different data formats and additional data channels. The current format (Digital FM Bi-phase, 4800 baud) provides noise rejection. The system receiver removes FM carrier noise, generates data clock, and buffers data for use by an IBM or compatible personal computer.

As the drill string is lengthened by adding drill rod, the coaxial cable is unspooled. The unspooled cable is attached to the battery pack and coil. The latter are mounted on the rotating drill pipe which extends behind the hydraulic head. The coil couples the AC signal between the rotating drill pipe and the stationary coil and receiver, which are mounted on the drilling platform. The receiver converts the AC signal into a serial bit stream. A computer equipped with a telemetry serial card receives the data and displays down-hole measurements in real time.

System Adaptability

The electronics package, located near the drill bit, is easily adaptable to different sensors or data formats. Adaptability is gained by using an Actel 1020B programmable logic array. This small-surface mounted Integrated Circuit (IC) contains some 2000 logic gates. The Actel 1020B controls the data-stream format, logic clock, and digital interfaces. The Actel 1020B is programmed to provide the serial bit stream as bi-phase and non-return to zero (NRZ) digital. These two formats cover a wide range of communications systems including fiber optic, hardwire, and radio frequency (RF).

The system has a bit rate of 2400 bits per second (bps), but the bit rate can be easily increased. A practical limit to this FM system is ~ 30,000 bps. However, if the signal coupling at the surface continues to be strong and noise-immune, the Actel bi-phase output could drive the coaxial system directly. The bi-phase data rate could exceed 100,000 bps. Data rates that high are approaching imaged data requirements.

Another important attribute of adaptability is to provide different supply voltages for different sensors. Only battery power (30V) is supplied on the coaxial cable. Once received, this voltage is converted to four different voltages: +12V, -12V, +5V, and -5V. A DC-to-DC converter generates these different voltages. The converter increases battery life by reducing current drain from the batteries and allowing the battery voltage to range from 18V to 32V without affecting sensor electronics. A second DC-to-DC converter generates the 1300V GRS bias voltage. Current requirement for the down-hole electronics is only 32 milliamps (ma) @ 30V.

Down-hole Components

Down-hole components of the gamma ray detection sensor system being demonstrated consist of a GRS, a multichannel analyzer, a 1300V power supply, a signal conditioning and transmitter board, and a coil containing coaxial cable for transmitting data to the surface. The down-hole components are contained within O-ring sealed aluminum tubes to protect them from the drilling environment. The GRS detector is placed forward, toward the drill bit. The coil is in the rear to accommodate communication back to the surface.

Up-hole Components

The up-hole system consists of a battery pack/coil, pickup coil, receiver, and a personal computer. During drilling, the system monitors: (1) gamma radiation by gamma ray spectrometry, (2) pitch, roll and azimuth using the orientation sensors, (3) the +12V and -12V required at the down-hole signal conditioning and transmitter board, (4) the up-hole battery voltage as measured down-hole, and (5) two temperatures associated with the detector and instrumentation.

Cable Deployment System

The cable is contained in a spool located with the down-hole components of the system. The cable from the down-hole instrument package is pulled through each piece of drill pipe and through the drill head to the battery pack/coil mounted on a spindle at the rear of the drill head and is connected to the up-hole components. The coaxial cable is pulled through each section of drill pipe and the drill head using fish tape. The spindle leads to the drill fluid handling system. Drill fluid pressure is normally in the range of 300 psi (1.435 kilopascals (kPa)) to 500 psi (2.392 kPa), but can go as high as 1500 psi (7.177 kPa). A cord grip fitting is used to seal against the 0.07" (1.8 mm) outside diameter (OD) coaxial cable. The

65

sealing grommet in the cord grip fitting is slit so that it can be removed from the cable, allowing the connector to pass through the body of the cord grip fitting. This arrangement has been tested to 600 psi (2.871 kPa) air, which is approximately 3000 psi (14.354 kPa) water, without leakage (Sandia, 1999).

Data Collection System

The data collection system is comprised of four parts: a computer, stationary magnetic pick-up coil and receiver, battery pack and magnetic coil, and the down-hole electronics package. The coil couples the FM signal between the rotating drill pipe and the stationary coil and receiver, which are mounted on the drilling platform. The receiver converts the FM signal into a serial bit stream. A computer equipped with a telemetry serial card receives the data and displays down-hole measurements in real time.
The EMWD system provides real-time data on an 8 differential/single analog multiplexer and any number of digital channels. Sampling speed from analog channels can reach 100 kHz. For the EMWD-GRS system, three digital channels are used. Readings are taken at a rate of 20 per second. The telemetry system is programmable firmware that can support many different data formats and additional data channels. The current format (Digital FM Bi-phase, 4800 baud) provides noise rejection. An SNL-designed receiver removes FM carrier noise, generates data clock, and buffers data for use by an IBM or compatible personal computer. A 36V rechargeable battery pack can supply down-hole instrumentation power for more than 24 hours of drilling. A DC to DC converter increases battery life by reducing battery current drain and allowing the battery voltage to range from 18 to 36V without affecting sensor electronics and data quality. The battery pack remains topside for easy maintenance (Sandia, 1999).

The EMWD-GRS gamma calibration and field measurement procedure is included as Appendix A.

Drilling Platform

The EMWD system can be adaptable for use with most drilling platforms. The subcontractor to perform the HDD has not been awarded at the time of writing of this SAP. The drilling platform to be used for this project will be a directional boring system of adequate size, strength, and capability to perform the HDD scope of work. Upon the award of the subcontract, the drill rig equipment descriptions and specifications (including the bit tracking system) will be provided as Appendix B to this SAP. The operating procedure for HDD will subsequently be included as an appendix to the IWCP.

66

APPENDIX C

Regulator Documentation and Correspondences

67

STATE OF COLORADO

Roy Romer, Governor
Patti Shwayder, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

HAZARDOUS MATERIALS AND WASTE MANAGEMENT DIVISION
http://www.cdphe.state.co.us/hm/

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-3300
Fax (303) 759-5355

222 S. 6th Street, Room 232
Grand Junction, Colorado 81501-2768
Phone (970) 248-7164
Fax (970) 248-7198

Colorado Department
of Public Health
and Environment

April 22, 1998

Mr. Bill Fitch
Building 123 Project Manager
U.S. Department of Energy
P.O. Box 928
Golden, CO 80402-0928

RE: Building 123 Demolition Plan Approval

Dear Mr. Fitch:

The Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division (the Division), has reviewed the *Demolition Plan for Building 123 Demolition Project* (hereafter called the Plan) submitted for the Rocky Flats Environmental Technology Site (RFETS) on February 17, 1998. The Close-Out Radiological Survey Plan for the 123 Cluster has been provided to the Division. Currently, final surveys have been completed for the east-wing of Building 123 and Buildings 114 and 123S. Based on our review of the information provided, all remaining materials and structures within these buildings have met the unrestricted release standards, with the exception of the concrete slab. Contaminated areas within the slab have been sealed with a weather proof epoxy coating and covered with a steel plate. Final surveys for Building 113 and the west-north wing of Building 123 have not been completed. As a result, the Site is not presently able to demonstrate that those remaining structures have met the unrestricted release standards.

Although the sequence of areas to be demolished may have changed, based on our conversations with the Site, the remaining information in the Plan is accurate. The Division hereby approves the Demolition Plan for Building 123 Demolition Project. Although ultimate disposition of the slab is pending, demolition of the surrounding walls and roof can proceed. This approval, however, does not include Building 113 and the west-north wing of Building 123. Once the final radiological survey results have been provided to the Division for review, the Division will make a determination on the information. Once we have completed our review, we will issue our decision as to whether or not the Site can proceed with the demolition of these buildings.

If you have any questions regarding this matter, please contact Chris Gilbreath at (303) 692-3371.

Sincerely,

Steve Tarlton

Steve Tarlton
D&D Project Coordinator

cc: T. Rehder, EPA
S. Gunderson, CDPHE
D. Miller, AGO
K. Dorr, Kaiser-Hill, T-130F

68

CERTIFICATION OF CLOSURE FOR THE BUILDING 123 COMPONENTS OF RCRA UNIT 40

Prepared By:
Rocky Mountain Remediation Services, L.L.C.

Certified By:
Dennis Pontius, P.E., EnviroTemps, Inc.

CERTIFICATION OF CLOSURE
FOR THE BUILDING 123 COMPONENTS OF
RCRA UNIT 40

REVISION 0

MAY 1998

69

Attachment II

CERTIFICATION OF CLOSURE
FOR THE BUILDING 123 COMPONENTS OF RCRA UNIT 40

TABLE OF CONTENTS

APPENDICES

1.0 EXECUTIVE SUMMARY

RCRA Unit 40 in Building 123 is an interim status unit. Closure was done in accordance with the Closure Plan for Building 123 Components of RCRA Unit 40, November 1997 (Closure Plan) and the requirements of the Colorado Hazardous Waste Regulations, 6 CCR 1007-3, Part 265.

All above-ground components of RCRA Unit 40 in Building 123 were removed and managed as RCRA listed mixed waste in accordance with Option 2 of the Closure Plan. This waste will be sent to an approved Treatment Storage and Disposal Facility (TSDF) for disposition.

Closure of the pipe chases and sumps in Room 156 and 158 was done in accordance with Option 1 (decontamination) of the Closure Plan. Analytical testing confirmed that these components met RCRA Clean Closure Standards.

Closure of the pipe chases and sump in Room 157 was also done accordance with Option 1 of the Closure Plan. Analytical testing showed that nickel was present at 111 ppb which is 11 ppb above the Tier 2 standard. Since nickel is not identified as a contaminant of concern nor is it a RCRA regulated hazardous waste, CDPHE has determined that no further action will be required for Sump 157.

Closure of the sump in Room 125 and the underground piping did not meet the Closure Performance Standards. The rinsate sample for Room 125 exceeded standards for lead and rinsate sample for the underground piping exceeded standards for chromium and lead. Remediation of the Room 125 sump and the underground piping will be deferred to the Environmental Restoration (ER) Department. ER will evaluate data from soil samples, groundwater monitoring, and the rinsate analysis to rank Individual Hazardous Substance Sites (IHSS's) 121, 148, and the under building contamination (UBC) associated with Building 123. This evaluation will determine what, if any, remediation will be required for these areas.

2.0 INTRODUCTION

The purpose of this report is to verify completion of RCRA Closure operations and to certify closure of the Building 123 components of RCRA Unit 40 that have met RCRA clean closure standards.

RCRA Unit 40 is the site-wide network of tanks, pipelines, and sumps, constructed to transport and temporarily store process waste from the point of origin to on-site treatment and discharge points. The Building 123 component of RCRA Unit 40 consisted of regulated process waste lines (above and below grade), sumps, and pump stations. This process waste system was used to transport laboratory wastes generated in Building 123, to Building 374 for treatment.

Closure of RCRA Unit 40 in Building 123 (an interim status unit) was done in accordance with the Closure Plan for Building 123 Components of RCRA Unit 40, November 1997 (Closure Plan) and the requirements of the Colorado Hazardous Waste Regulations, 6 CCR 1007-3, Part 265. The Closure Plan was approved by the Colorado Department of Public Health and Environment (CDPHE) on January 8, 1998. Partial closure of RCRA Unit 40 was an element of a larger project to decommission Buildings 123, 113, 114, and 123S. This project was conducted as an accelerated remedial action approved under the Building 123 Proposed Action Memorandum (PAM). The PAM is a decision document for the decommissioning of Building 123 and was approved by CDPHE on August 25, 1997.

Rocky Mountain Remediation Services, L.L.C., retained an independent Professional Engineer from EnviroTemps (ET) to witness the closure activities and perform this certification. This report provides evidence to support the closure determinations by the Owner/Operator and verification by an independent Professional Engineer (PE), as required by 6 CCR 1007-3, Section 265.115, for RCRA closure of an

71

interim status unit.

3.0 HISTORICAL OVERVIEW AND WASTE CHARACTERIZATION

Building 123 was constructed in 1953 and was used as an analytical laboratory, dosimetry, and instrument calibration facility. The building also was used for medical research, storage for all radiological health records, office space for radiation health specialists, and a laboratory for calibration of criticality alarms. The process waste system in Building 123 was used from 1953 through 1997 when the building was decommissioned.

The building was modified several times through its operation. The process waste system was modified in 1968 when a extension to the east wing was built, in 1972 when the west wing was added to the building, in 1974 when portions of the above-ground piping were installed and old underground lines were grouted, in 1989 when the underground line to Valve Vault 18 was replaced, and finally in 1995 when various upgrades were made to the above-ground piping. A detailed description of the history of the process system in Building 123 can be found in the Closure Plan.

The process waste system incorporated into RCRA Unit 40 included the system components in Rooms 103, 103A, 105, 111, 112, 113B, 121, 123, 123A, 125, 126C, 127, 155, 155B, 156, 157, and 158; the active underground line (double walled pipe) between Room 158, Valve Vault 18, and Tank D-853 in Building 428; sumps in Rooms 125, 156, 157, and 158, and pipe chases in Room 156, 157, and 158.

The Closure Plan describes the waste streams which were disposed of in the Building 123 component of RCRA Unit 40, and also provides a list of EPA waste codes used in the building.

4.0 CLOSURE CERTIFICATION ACTIVITIES

4.1 BUILDING 123 RCRA CLOSURE TEAM

Closure activities were conducted in February and March 1998 by Resource Technologies Group (RTG) under subcontract to Denver West Remediation and Construction (DWRC) and Kaiser-Hill. RMRS provided management and technical support of the Building 123 Decommissioning project for Kaiser-Hill. As stated above, RMRS subcontracted independent Professional Engineering services from EnviroTemps.

4.2 CLOSURE OPTIONS

The Closure Plan listed three options for closure of RCRA Unit 40 in Building 123 which are summarized below. Details may be found in the Closure Plan and in the Construction Package for Building 123 Strip-Out.

<u>Option 1</u> - Decontamination using a solution capable of removing the contaminates of concern and testing the final rinsate to verify treatment standards according to the Rocky Flats Environmental Technology Site (RFETS) RCRA Permit, Part 10, Closure, Section C, "Clean Closure by Decontamination".

<u>Option 2</u> - Manage as RCRA mixed waste with no on-site treatment.

<u>Option 3</u> - Debris treatment as defined by RFETS RCRA Permit, Part 10, Closure, Section D, "Debris Rule Decontamination".

72

4.3 BUILDING 123 CLOSURE ACTIVITIES

RCRA Unit 40 in Building 123 was divided into three major components for closure.

Above-ground system components. All above-ground process waste piping (steel and PVC), pumps, and polyethylene pump containments were managed under Option 2. These system components were stripped-out and packaged in waste crates as low level mixed waste for subsequent disposal at an approved and permitted Treatment Storage and Disposal Facility (TSDF).

Pipe chases and sumps. The pipe chases and sumps were managed under Option 1. First the pipe chases and sumps were washed with a solution of trisodium phosphate and sodium carbonate. The volume of solution used was approximately 3 times the volume of the chases and sumps. The chases and sumps were then liberally rinsed with water. Finally, a specified volume of water which did not exceed 5% the capacity of each pipe chase and sump was used as a final rinse. Composite samples of the rinsate were collected for analysis. Three composite samples were collected: one for each sump and associated pipe chases in Room 156, 157, and 158. A separate sample was collected for the sump in Room 125 (Room 125 does not have any pipe chases). All waste generated during the pipe chase and sump closure activities was routed to the process waste system downstream of the closure activities (Building 374) or packaged as a listed mixed waste.

Underground piping. The underground piping was managed under Option 1. This piping begins in Room 158, where the process waste system exits Building 123. It drains to Valve Vault 18, passes through Valve Vaults 17 and 16, and discharges to Tank D-853 in Building 428. This entire stretch of piping was washed with a solution of trisodium phosphate and sodium carbonate. The volume of solution used was approximately 3 times the volume of the piping and the D-853 tank. The piping was then liberally rinsed with water. Finally, a specified volume of water which did not exceed 5% the capacity of the piping and Tank D-853, was used as a final rinse. A sample of the rinsate was collected from the D-853 tank for analysis.

5.0 COMPARISON OF SAMPLE RESULTS TO CLOSURE PERFORMANCE STANDARDS

5.1 SUMMARY OF CLOSURE PERFORMANCE STANDARDS

The Closure Performance Standards are defined in the Closure Plan. A summary of the Closure Performance Standards is provided below.

Option 1: Decontamination.

1. An appropriate solution must be used for decontamination.

2. The system must be flushed with the decontamination solution to remove trace amounts of acids or bases.

3. Rinsate samples must be evaluated against the final rinsate closure performance standards from the Rocky Flats Cleanup Agreement (RFCA) Permit, Part X.

4. The final rinsate volume must not exceed 5% of the capacity of the system.

5. All visible waste residuals must be removed.

73

6. The final rinsate concentrations of priority pollutants and heavy metals must be below the Tier 2 action levels as defined in Attachment 5 of RFCA.

7. The pH of the rinsate must be between 6 and 9.

Option 2: Dispose as Mixed Waste

1. Waste generated must be managed as RCRA mixed waste with EPA Waste Codes of F001, F002, and F005.

2. The waste generated must be managed in accordance with applicable state and federal regulations.

Option 3: Debris Treatment

Since Option 3 was not used during the closure of RCRA Unit 40 in Building 123, the Closure Performance Standards will not be summarized.

5.2 COMPARISON OF CLOSURE ACTIVITIES WITH THE PERFORMANCE STANDARDS

The following is a comparison of each major component of RCRA Unit 40 in Building 123 to the Closure Performance Standards. This comparison demonstrates whether the unit may be closed. Tables summarizing all the sample analytical results may be found in Appendix A.

5.2.1 Above-ground system components.

1. All above-ground process waste piping and ancillary equipment was packaged as mixed waste with the waste code F001, F002 and F005.

2. Since the above-ground piping was handled according to Option 2 (managed as a hazardous waste) it was sampled for Land Disposal Restriction (LDR) standards according to 40 CFR 268.40 and 268.48. Samples of both the PVC and the steel pipe were collected. All pipe was determined to comply with the LDR standards.

Conclusion: The above-ground components of RCRA Unit 40 met the Closure Performance Standards. Waste generated has been managed as RCRA mixed waste with EPA Waste Codes of F001, F002, and F005, and the packaged waste is being managed in accordance with RFETS procedures, which meet applicable state and federal regulations for on-site storage at a TSDF.

5.2.2 Pipe Chases and Sump in Room 156

1. A solution of trisodium phosphate/sodium carbonate was used for decontamination.

2. The pipe chases and the sump in Room 156 were adequately flushed with the decontamination solution to remove trace amounts of contaminants of concern as identified in the Closure Plan.

3. The rinsate sample has been evaluated against the performance standards from the RFCA Permit, Part X. The comparison can be found in Appendix B.

74

4. The final rinsate volume used in the pipe chases did not exceed 6 pints. The final rinsate volume used in the sump did not exceed 25 gallons. These volumes are less than 5% of the capacity of the components.

5. All visible waste residuals were removed during washing and rinsing of the sump. The pipe chases were not visible.

6. No contaminants were found to exceed Tier 2 Action levels. As shown in Appendix B, the final rinsate concentrations of priority pollutants and heavy metals were below the Tier 2 action levels as defined in Attachment 5 of RFCA.

7. All rinsate was processed in the permitted, on-site, liquid waste treatment plant at Building 374.

Conclusion: Closure of the pipe chases and sump in Room 156 meet the Closure Performance Standards.

5.2.3 Pipe Chases and Sump in Room 157

1. A solution of trisodium phosphate/sodium carbonate was used for decontamination.

2. The pipe chases and the sump in Room 157 were adequately flushed with the decontamination solution to remove trace amounts of contaminants of concern as identified in the Closure Plan.

3. The rinsate sample has been evaluated against the performance standards from the RFCA Permit, Part X. The comparison can be found in Appendix B.

4. The final rinsate volume used in the pipe chases did not exceed 19.5 pints. The final rinsate volume used in the sump did not exceed 44 gallons. These volumes are less than 5% of the capacity of the components.

5. All visible waste residuals were removed during washing and rinsing of the sump. The pipe chases were not visible.

6. As shown in Appendix B, no contaminants of concern were found to exceed Tier 2 action levels. Nickel was present at 111 ppb which is 11 ppb above the Tier 2 standard. Since nickel is not identified as a contaminant of concern, nor is it a RCRA regulated hazardous waste, CDPHE has determined that no further action will be required for the sump in Room 157 (documented in correspondence between K-H and CDPHE dated April 3, 1998).

7. All rinsate was processed in the permitted, on-site, liquid waste treatment plant at Building 374.

Conclusion: Closure of the pipe chases and sump in Room 157 meet the Closure Performance Standards.

5.2.4 Pipe Chases and Sump in Room 158

1. A solution of trisodium phosphate/sodium carbonate was used for decontamination.

75

2. The pipe chases and the sump in Room 158 were adequately flushed with the decontamination solution to remove trace amounts of contaminants of concern as identified in the Closure Plan.

3. The rinsate sample has been evaluated against the performance standards from the RFCA Permit, Part X. The comparison can be found in Appendix B.

4. The final rinsate volume used in the pipe chases did not exceed 10.5 pints. The final rinsate volume used in the sump did not exceed 31 gallons. These volumes are less than 5% of the capacity of the components.

5. All visible waste residuals were removed during washing and rinsing of the sump. The pipe chases were not visible.

6. No contaminants were found to exceed Tier 2 Action levels. As shown in Appendix B, the final rinsate concentrations of priority pollutants and heavy metals were below the Tier 2 action levels as defined in Attachment 5 of RFCA.

7. All rinsate was processed in the permitted, on-site, liquid waste treatment plant at Building 374.

Conclusion: Closure of the pipe chases and sump in Room 158 meet the Closure Performance Standards.

5.2.5 Sump in Room 125

1. A solution of trisodium phosphate/sodium carbonate was used for decontamination.

2. The sump in Room 125 was adequately flushed with the decontamination solution to remove trace amounts of contaminants of concern as identified in the Closure Plan.

3. The rinsate sample has been evaluated against the performance standards from the RFCA Permit, Part X. The comparison can be found in Appendix B.

4. The final rinsate volume used in the sump did not exceed 2 gallons. This volume is less than 5% of the capacity of the sump.

5. All visible waste residuals were removed during washing and rinsing of the sump.

6. As shown in Appendix B, the final rinsate concentrations of priority pollutants and heavy metals were below the Tier 2 action levels as defined in Attachment 5 of RFCA, except for lead. The rinsate concentration for lead was 56 ppb and the action level for lead is 15 ppb.

7. All rinsate was processed in the permitted, on-site, liquid waste treatment plant at Building 374.

Conclusion: Closure of the sump in Room 125 did not meet the Closure Performance Standards. Remediation of this sump will be deferred to the Environmental Restoration (ER) Department. ER will evaluate data from soil samples, groundwater monitoring, and the rinsate analysis to rank Individual Hazardous Substance Sites (IHSS's) 121, 148 and

76

the under building contamination (UBC) associated with Building 123. This evaluation will determine what, if any, remediation will be required for this area.

5.2.6 Underground Pipe from Room 158, Building 123 to Tank D853 in Building 428.

1. A solution of trisodium phosphate/sodium carbonate was used for decontamination.

2. The piping was adequately flushed with the decontamination solution to remove trace amounts of contaminants of concern as identified in the Closure Plan.

3. The rinsate sample has been evaluated against the performance standards from the RFCA Permit, Part X. The comparison can be found in Appendix B.

4. The final rinsate volume used in the piping and tank did not exceed 113 gallons. This volume is less than 5% of the capacity of the piping and Tank D853.

5. The piping is underground and therefore not visible for inspection.

6. As shown in Appendix B, the final rinsate concentrations of priority pollutants and heavy metals were below the Tier 2 action levels as defined in Attachment 5 of RFCA, except for chromium and lead. The analysis of the rinsate revealed 588 ppb chromium and 21.7 ppb lead remained within the underground portion of the line. The action level of chromium is 100 ppb, and the action level for lead is 15 ppb.

7. All rinsate was processed in the permitted, on-site, liquid waste treatment plant at Building 374.

Conclusion: Closure of the underground piping did not meet the Closure Performance Standards. Remediation of the underground piping will be deferred to the Environmental Restoration (ER) Department. ER will evaluate data from soil samples, groundwater monitoring, and the rinsate analysis to rank Individual Hazardous Substance Sites (IHSS's) 121, 148 and the under building contamination (UBC) associated with Building 123. This evaluation will determine what, if any, remediation will be required for this area.

77

6.0 CONCLUSION AND CLOSURE CERTIFICATION

Based upon observations and investigations presented in this report, the Closure Performance Standards stated in Section 5.0 of this report are accurate.

The undersigned hereby certifies the following:

1. The following components of RCRA Unit 40 in Building 123 at the Rocky Flats Environmental Technology Site met RCRA Clean Closure standards prescribed in the Closure Plan and meet the requirement of the Colorado Hazardous Waste Act (CHWA) regulations for RCRA closure under interim status, as defined in 6 CCR 1007-3, Section 265, Subpart G:

    - all above-ground piping, removable ancillary equipment and secondary containment.
    - sumps and pipe chases in Rooms 156, 157 and 158.

2. The following components of RCRA Unit 40 in Building 123 will be deferred to ER for ranking and future remediation as applicable:

    - the Sump in Room 125 (due to 56 ppb Pb).
    - the underground pipe from Building 123 to Building 428 (due to 588 ppb Cr and 21.7 ppb Pb).

Professional Engineer

5-28-98

Date

Dennis W. Pontius, P.E.
EnviroTemps, Inc.
555 Zang Street
Suite 104
Lakewood, CO 80228

COLORADO REGISTERED
DENNIS W. PONTIUS
31028
PROFESSIONAL ENGINEER

78

7.0 REFERENCES

Closure Plan for Building 123 Components of RCRA Unit 40 (Closure Plan), Revision 0, November 1997.

Construction Package for Building 123 Strip-Out, Revision 14, February 27, 1998.

Proposed Action Memorandum for the Decommissioning of Building 123 (PAM), Revision 6, dated March 26, 1998.

Waste Management Plan for Building 123, Revision 1, dated March 1998.

79

SW-A-003947

35 mm

DRAWING

PLATE 1

35 mm

DRAWING

PLATE 2

35 mm

DRAWING

PLATE 3

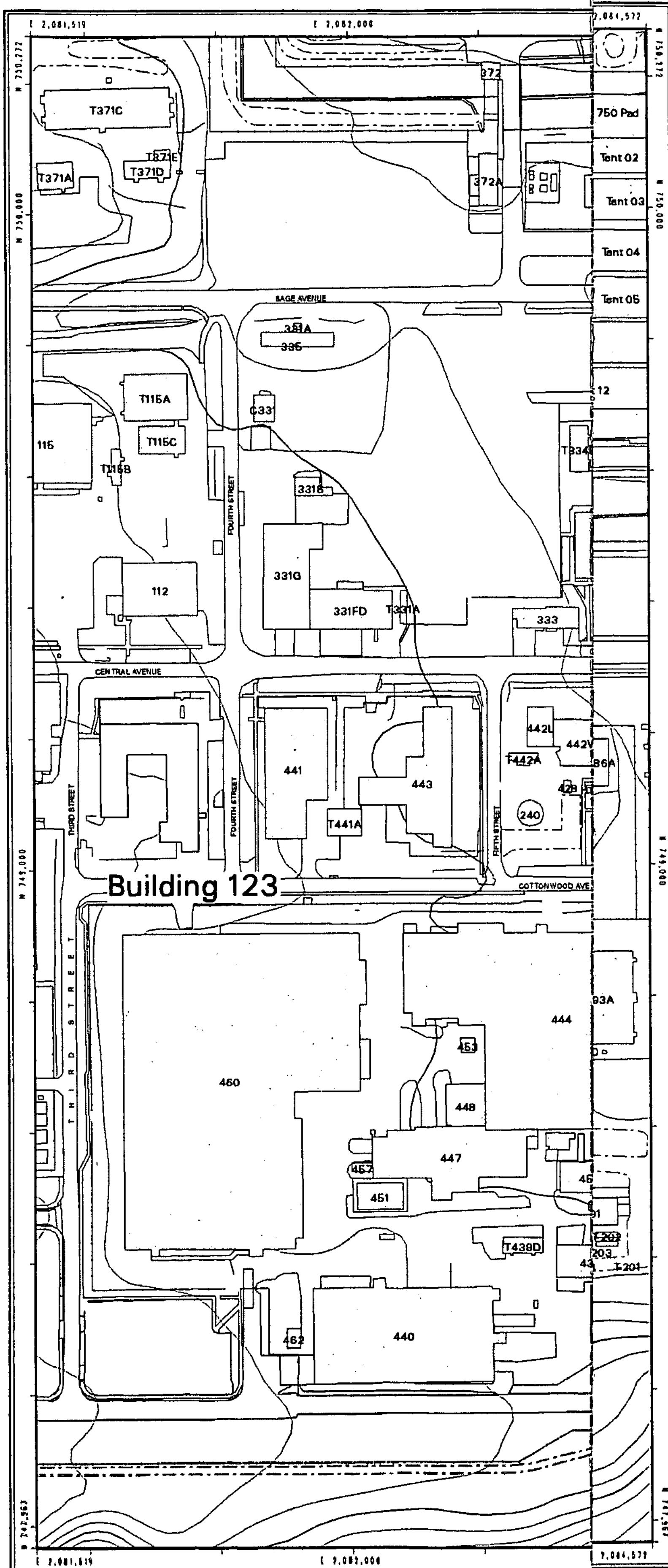


Figure 1-1

Site Location Map

EXPLANATION

Standard Map Features

- Buildings and other structures
- Paved roads fill
- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (5-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution.
DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 2970
1 inch represents approximately 248 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

RMRS **Rocky Mountain Remediation Services, L.L.C.**
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

For more information about GIS
Please Contact Wendell Checks
at ext. 7707 or page 212-6669
GIS website: http://rfetshp/gis

MAP ID: 2k-0153 March 27, 2000

NT_Svr w:/projects/fy2k/2k-0153/location.aml

53

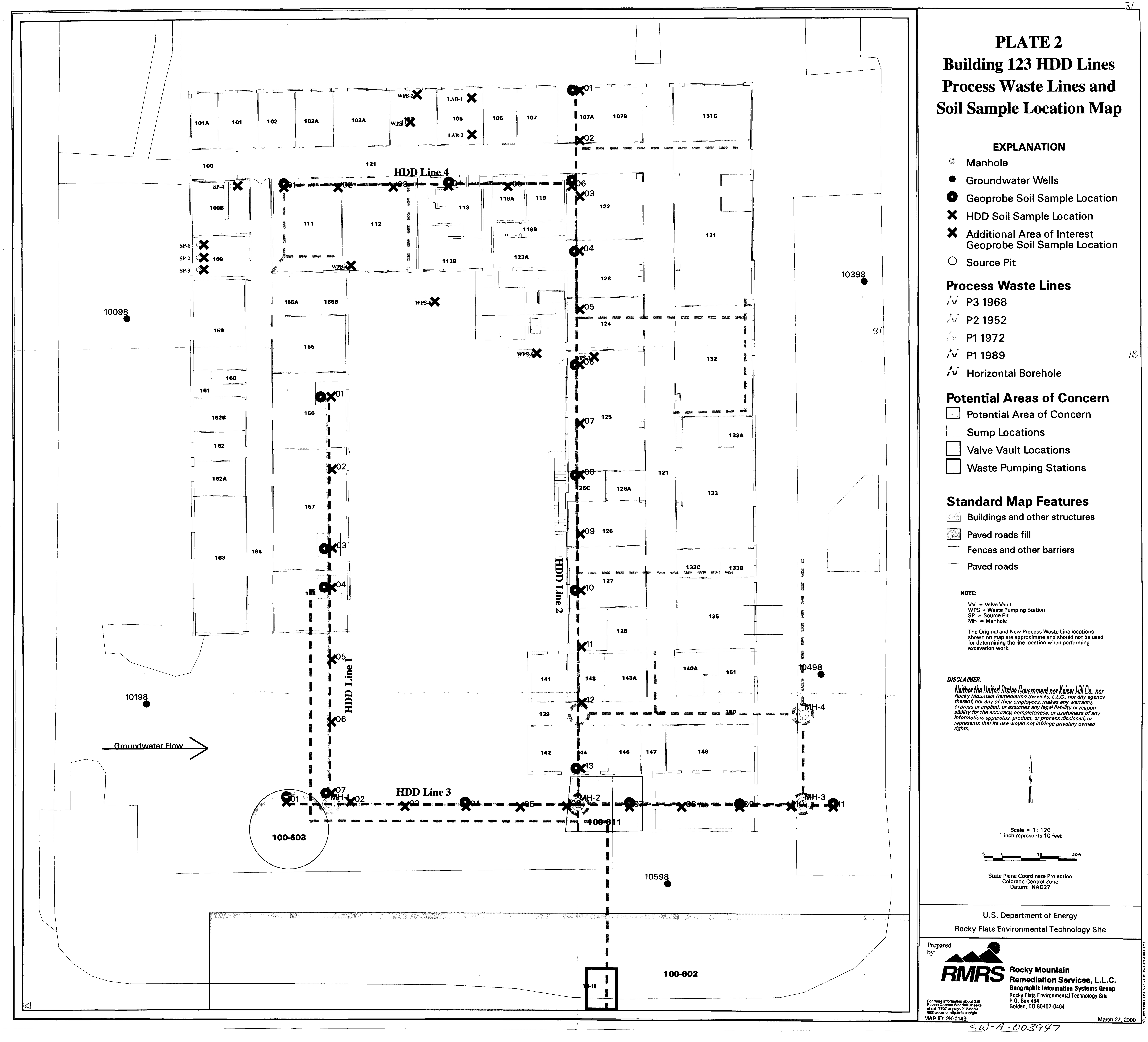
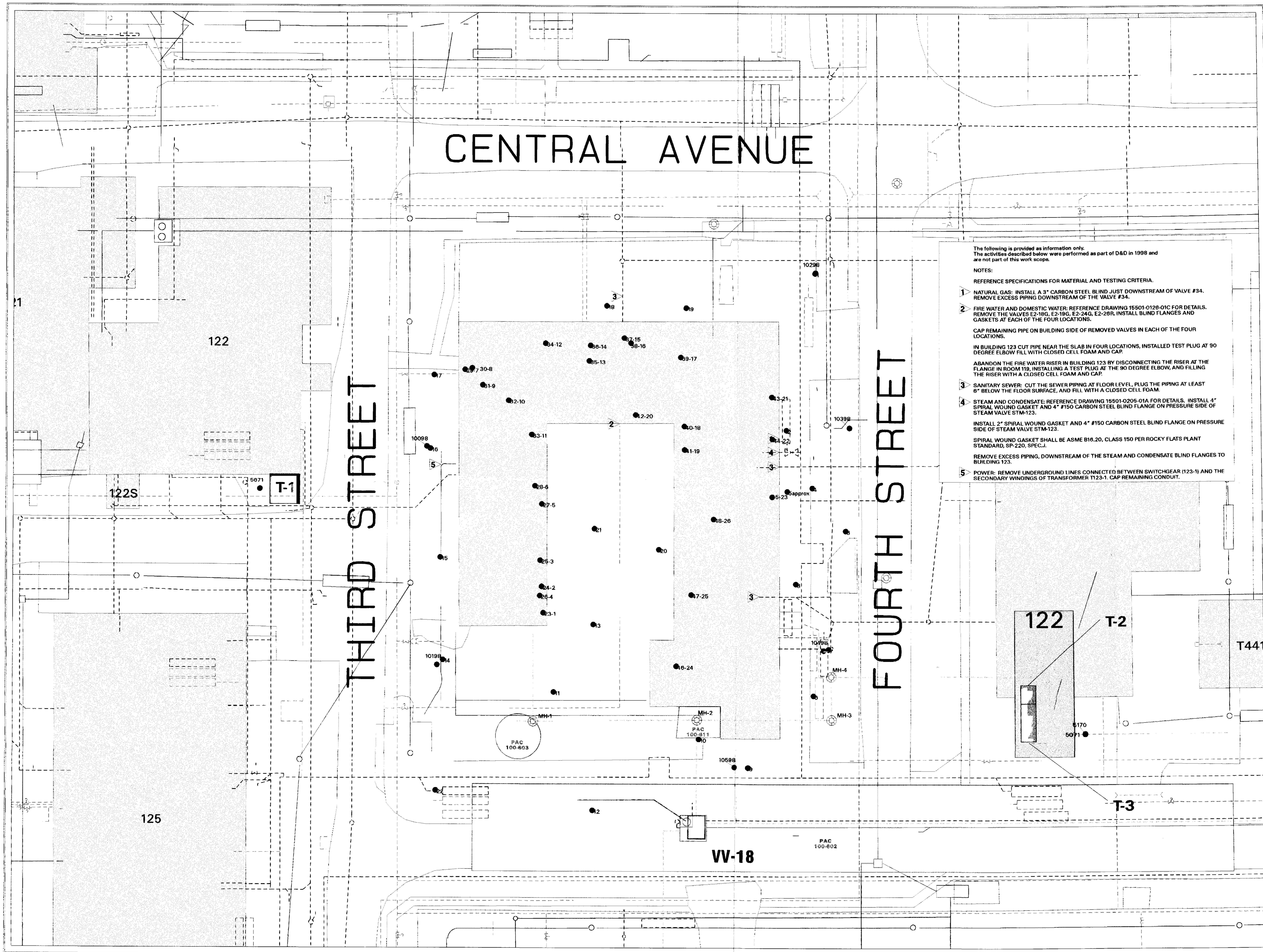


PLATE 2
Building 123 HDD Lines Process Waste Lines and Soil Sample Location Map
EXPLANATION
Manhole
Groundwater Wells
Geoprobe Soil Sample Location
HDD Soil Sample Location
Additional Area of Interest Geoprobe Soil Sample Location
Source Pit
Process Waste Lines
P3 1968
P2 1952
P1 1972
P1 1989
Horizontal Borehole
Potential Areas of Concern
Potential Area of Concern
Sump Locations
Valve Vault Locations
Waste Pumping Stations
Standard Map Features
Buildings and other structures
Paved roads fill
Fences and other barriers
Paved roads
NOTE:
VV = Valve Vault
WPS = Waste Pumping Station
SP = Source Pit
MH = Manhole
The Original and New Process Waste Line locations shown on map are approximate and should not be used for determining the line location when performing excavation work.
DISCLAIMER:
Neither the United States Government nor Kaiser Hill Co. nor Rocky Mountain Remediation Services, L.L.C., nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.
Scale = 1 : 120
1 inch represents 10 feet
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Prepared by:
RMRS
Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464
MAP ID: 2K-0149
March 27, 2000
HDD Line 1
HDD Line 2
HDD Line 3
HDD Line 4
Groundwater Flow
100-603
100-611
100-602
MH-1
MH-2
MH-3
MH-4
10098
10198
10398
10498
10598
SP-1
SP-2
SP-3
SP-4
LAB-1
LAB-2
WPS-2
WPS-4
101A
101
102
102A
103A
105
106
107
107A
107B
131C
100
121
109B
109
111
112
113
113B
119A
119
119B
122
123A
123
131
124
132
155A
155B
155
159
160
161
156
162B
162
162A
157
163
164
125
133A
126C
126A
133
126
133C
133B
127
135
128
140A
151
141
143
143A
139
150
142
146
147
149
SW-A-003947



The following is provided as information only.
The activities described below were performed as part of D&D in 1998 and are not part of this work scope.

NOTES:

REFERENCE SPECIFICATIONS FOR MATERIAL AND TESTING CRITERIA.

1 NATURAL GAS: INSTALL A 3" CARBON STEEL BLIND JUST DOWNSTREAM OF VALVE #34. REMOVE EXCESS PIPING DOWNSTREAM OF THE VALVE #34.

2 FIRE WATER AND DOMESTIC WATER: REFERENCE DRAWING 15501-0126-01C FOR DETAILS. REMOVE THE VALVES E2-18G, E2-19G, E2-24G, E2-26R. INSTALL BLIND FLANGES AND GASKETS AT EACH OF THE FOUR LOCATIONS.

CAP REMAINING PIPE ON BUILDING SIDE OF REMOVED VALVES IN EACH OF THE FOUR LOCATIONS.

IN BUILDING 123 CUT PIPE NEAR THE SLAB IN FOUR LOCATIONS, INSTALLED TEST PLUG AT 90 DEGREE ELBOW FILL WITH CLOSED CELL FOAM AND CAP.

ABANDON THE FIRE WATER RISER IN BUILDING 123 BY DISCONNECTING THE RISER AT THE FLANGE IN ROOM 119, INSTALLING A TEST PLUG AT THE 90 DEGREE ELBOW, AND FILLING THE RISER WITH A CLOSED CELL FOAM AND CAP.

3 SANITARY SEWER: CUT THE SEWER PIPING AT FLOOR LEVEL, PLUG THE PIPING AT LEAST 6" BELOW THE FLOOR SURFACE, AND FILL WITH A CLOSED CELL FOAM.

4 STEAM AND CONDENSATE: REFERENCE DRAWING 15501-0205-01A FOR DETAILS. INSTALL 4" SPIRAL WOUND GASKET AND 4" #150 CARBON STEEL BLIND FLANGE ON PRESSURE SIDE OF STEAM VALVE STM-123.

INSTALL 2" SPIRAL WOUND GASKET AND 4" #150 CARBON STEEL BLIND FLANGE ON PRESSURE SIDE OF STEAM VALVE STM-123.

SPIRAL WOUND GASKET SHALL BE ASME B16.20, CLASS 150 PER ROCKY FLATS PLANT STANDARD, SP-220, SPEC.J.

REMOVE EXCESS PIPING, DOWNSTREAM OF THE STEAM AND CONDENSATE BLIND FLANGES TO BUILDING 123.

5 POWER: REMOVE UNDERGROUND LINES CONNECTED BETWEEN SWITCHGEAR (123-1) AND THE SECONDARY WINDINGS OF TRANSFORMER T123-1. CAP REMAINING CONDUIT.

PLATE 1
Building 123 Slab Utilities and Previous Borehole Investigation Location Map

EXPLANATION

- Manhole
- Previous Investigation Borehole Locations
- Groundwater Wells

General Utilities

- Water Lines
- Natural Gas Lines
- Process Waste Lines
- Storm Sewer Lines
- Sewer Lines
- Electric Lines

Potential Areas of Concern

- Potential Area of Concern
- Tanks of Concern
- Foamed & Stabilized Tanks (Source Removed - Interim Status)
- Remaining Tanks
- Process Waste IHSS Locations (Former OU 9 IHSSs)
- Valve Vault Locations

Standard Map Features

- Buildings and other structures
- Paved roads fill
- Fences and other barriers
- Paved roads

NOTE:

VV = Valve Vault

The Original and New Process Waste Line locations shown on map are approximate and should not be used for determining the line location when performing excavation work.

DISCLAIMER:
Neither the United States Government nor Kaiser Hill Co., nor Rocky Mountain Remediation Services, L.L.C., nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

Scale = 1 : 300
1 inch represents 25 feet

10 0 20 40ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
RMRS Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 2K-0148
March 24, 2000

NT_Svr w:/projects/fy2k/2k-0148/plate1-new.aml

SW-A-003947

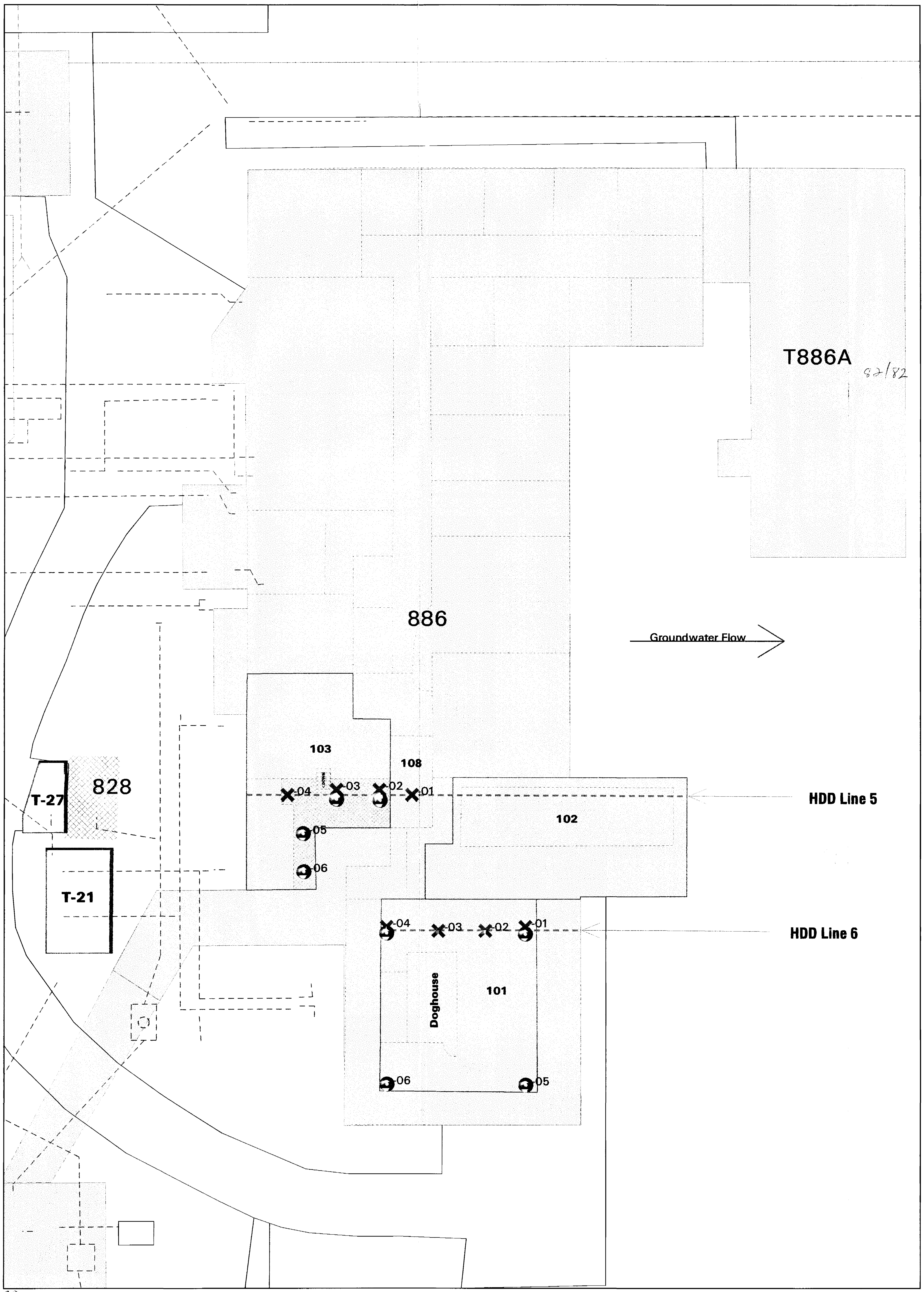


PLATE 3
Building 886 HDD Lines Process Waste Lines and Soil Sample Location Map

EXPLANATION

- Geoprobe Soil Sample Location
- HDD Soil Sample Location
- Horizontal Borehole

General Utilities

- Water Lines
- Natural Gas Lines
- Process Waste Lines
- Storm Sewer Lines
- Sewer Lines
- Electric Lines
- Tanks of Concern
- Building 886 Room 103 Pit Area

Standard Map Features

- Buildings and other structures
- Paved roads fill
- Demolished Buildings
- Fences and other barriers
- Paved roads

NOTE:
The Original and New Process Waste Line locations shown on map are approximate and should not be used for determining the line location when performing excavation work.

DISCLAIMER:
Neither the United States Government nor Kaiser Hill Co., nor Rocky Mountain Remediation Services, L.L.C., nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

Scale = 1 : 120
1 inch represents 10 feet

5 0 10 20ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Rocky Mountain
Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

For more information about GIS
Please Contact Wendell Cheeks
at ext. 7707 or page 212-6669
GIS website: http://rfetshp/gis

MAP ID: 2K-0178

March 27, 2000

NT_Svr w:/projects/fy2k/2k-0178/plate3-sap.aml

SW-A-003947